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Canada

Improving Energy Performance in Canada

Report to Parliament Under the *Energy Efficiency Act*

2001-2002

CANADA'S NATURAL RESOURCES NOW AND FOR THE FUTURE

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Her Excellency the Right Honourable Adrienne Clarkson,
C.C., C.M.M., C.D.
Governor General of Canada and Commander-in-Chief

Your Excellency,

I have the honour to present the *Report to Parliament Under the* Energy Efficiency Act for the fiscal year ending March 31, 2002, in accordance with Section 36 of the Act.

Respectfully submitted,

Herb Dhaliwal
Minister of Natural Resources Canada

105-01554/

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Minister's Foreword

This ninth report under the *Energy Efficiency Act* describes what the Government of Canada, through Natural Resources Canada (NRCan), has done in 2001–2002 to help improve our country's energy efficiency and use of renewable energy.

The Government has been working to improve energy efficiency for a number of years. Specifically, NRCan has been helping industry, governments and individual Canadians reduce energy use and save money through voluntary initiatives, programs and regulations. NRCan also supports innovative research and development, leading to new technologies that have made Canada a world leader in energy efficiency and renewable energy.

The focus of the Government of Canada's programs has changed over time from energy conservation to addressing climate change. As we implement the Kyoto Protocol in Canada, we as a country will need to reduce our greenhouse gas emissions. Improving our use of energy at home, at work and on the road is the most effective way to address this global challenge.

We all need to take action — companies of all sizes, governments at all levels and individual Canadians. In our *Climate Change Plan for Canada*, we propose that every Canadian set the goal of reducing personal greenhouse gas emissions by an average of one tonne per year by 2008–2012. Making the right choices in our daily lives will bring us closer to this goal.

By promoting the responsible use of our energy resources, NRCan builds on the Government of Canada's commitment to ensuring the quality of life in our communities, a healthy environment and continued economic prosperity — for the Canada we want, for ourselves and for future generations.

Herb Dhaliwal

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Minister of Natural Resources Canada

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Executive Summary

With its ratification of the Kyoto Protocol in December 2002, Canada has strengthened its commitment to doing its part to address the global issue of climate change. Canada's highly industrialized and resource-based economy makes reducing greenhouse gas (GHG) emissions, which contribute to climate change, a particular challenge.

Canadians spend almost $104 billion per year on energy to heat and cool our homes and offices and to operate our appliances, cars and industrial processes. An abundance of energy from a variety of sources helps us overcome the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate. It has also favoured the development of industries that have a particularly high energy demand.

There are two types of energy use: primary and secondary. Primary energy use encompasses the total requirements for all users of energy, the energy required to transform one energy form to another (e.g., coal to electricity) and the energy used to bring energy supplies to the consumer. Secondary energy use is energy used by final consumers for residential, agricultural, commercial, industrial and transportation purposes.

In 2000 (the latest year for which data are available), secondary energy use accounted for 70.3 percent of primary energy use and 65.6 percent of GHG emissions.

The industrial sector is the largest energy user, accounting for 39.2 percent of total secondary energy use in 2000. The transportation sector is the second-largest energy user at 28.0 percent, followed by the residential sector at 17.0 percent, the commercial and institutional sector at 13.0 percent and the agriculture sector at 2.8 percent.

For the past decade, Natural Resources Canada (NRCan) has promoted energy efficiency and the use of alternative energy as a means to reduce GHG emissions. It has done this through initiatives under the department's Efficiency and Alternative Energy (EAE) program. The EAE program has provided a foundation for long-term processes that respond to evolving environmental and economic development priorities. It uses a variety of policy instruments, including leadership, information, voluntary actions, financial incentives, research and development and regulation.

There are four key factors that contribute to changes in energy use:

- Activity: Changes in the level of activity in a sector
- Structure: A shift toward more or less energy-intensive components of activity
- Weather: Fluctuations in the weather
- Energy efficiency: The level of energy consumption of a product or piece of equipment

As indicated in this report, increases in energy use are primarily due to increases in activity in the various sectors. These increases, however, would have been far greater without improved energy efficiency.

Between 1990 and 2000, the residential sector showed the greatest improvement in energy efficiency (15.1 percent). Transportation was second (11.3 percent), followed by the industrial sector (8.7 percent) and the commercial and institutional sector (2.7 percent).

Most of NRCan's EAE initiatives focus on improving energy efficiency by

- increasing the energy efficiency of new and existing buildings, equipment, systems and vehicles;
- persuading individuals and organizations to purchase buildings, equipment, systems and vehicles that are more energy efficient;
- ensuring that energy-consuming equipment is used in the most energy-efficient way possible;
- influencing the energy-use practices of individuals and organizations; and
- developing technologies to give consumers, industry and communities new opportunities to improve energy efficiency.

Improvements in energy efficiency contribute significantly to energy savings and environmental objectives. Similarly, changes in the fuel mix to less GHG-intensive fuels (e.g., from coal to natural gas) can in the short term help reduce GHG emissions. In the long term, reducing GHG emissions to 1990 levels or below will require greater use of alternative energy sources.

Solar, wind, wood and waste electric power consumption has steadily increased over the past 10 years. In 2000, Canadians consumed 9 terawatt hours (billions of gigawatt hours) of power from these sources.

Changing energy consumption patterns to obtain environmental and economic benefits is the main goal of NRCan's EAE initiatives. Measuring the effectiveness and progress of the initiatives is important to their continued success and viability.

NRCan monitors and tracks three aspects of program delivery:

- program outputs;
- program outcomes; and
- market outcomes.

Program outputs are the items that a program produces regularly, such as information and marketing materials, demonstration projects, financial incentives and regulations. These outputs are designed to lead to *program outcomes* – namely, achieving the goal of the particular program, such as changing the behaviour of groups targeted by that program. These outcomes can directly affect the amount and type of energy consumed in the market, therefore they contribute, in part, to observable *market outcomes*.

NRCan emphasizes partnership and cooperation with stakeholders such as other levels of government, the private sector and non-governmental organizations in the delivery of its programs. There are a number of cooperation agreements in place, primarily at the program level.

These initiatives engage Canadian society and all major sectors of the economy in new and more efficient approaches to secondary energy use – i.e., the consumption of energy in the residential, commercial and institutional, industrial and transportation sectors – and in the development and deployment of renewable energy sources.

Following is a brief overview of the work being done in each sector that highlights selected programs and indicators of their effectiveness and progress. All programs – their progress and accomplishments plus specific achievements for 2001–2002 – are fully described in the corresponding sector chapter. Program indicators are listed in Table 1 at the end of this section. A list of NRCan's EAE initiatives and expenditures in 2001–2002 is provided in Appendix 1.

Housing

The residential sector accounts for 17.0 percent of secondary energy use and 15.8 percent of GHG emissions. Between 1990 and 2000, residential energy use increased by 6.8 percent, and GHG emissions increased by 7.3 percent. This growth in energy use was largely driven by increased activity. However, improvements in energy efficiency, both through better construction of new homes and reduced energy use in the home, mitigated that increase. Without improvements in energy efficiency, supported by NRCan programs, the increase in energy use would have been 15.1 percent higher.

NRCan's residential building programs target three main subsectors – new houses, existing houses and residential equipment – and focus on single-detached and attached houses because they are the predominant residence type.

New Houses

Canada's ever-improving building codes have resulted in increasingly energy-efficient new homes. A review of air leakage rates shows that a home built before 1946 had a leakage rate of 10.73 air changes per hour (at 50 Pa). Today's more energy-efficient home has a leakage rate of 3.26.

NRCan's well-established R-2000 initiative continues to encourage Canadians to build even more energy-efficient houses. The R-2000 Standard exceeds energy efficiency and environmental responsibility requirements in current Canadian building codes. With an air leakage rate of only 1.27, R-2000-built homes outperform conventionally built homes.

Since 1998, NRCan's Super E™ program has helped export energy-efficient and environmentally friendly housing technology to foreign builders. As a result, the R-2000 concept has been adapted to international markets. To date, 54 houses have been built in Japan, and in the United Kingdom one house is complete and 31 are under construction.

Existing Houses

NRCan programs for existing houses encourage Canadians to increase the energy efficiency of their homes. Through the EnerGuide for Houses program, NRCan signed contracts with 15 delivery agents in 2001–2002 to offer personalized expert advice to homeowners on how to improve energy efficiency. This service is now available to 80 percent of Canadians.

On average, houses that were built before 1946 and evaluated under the program had potential energy savings of 75 gigajoules – that is, homeowners could reduce their energy use by almost 30 percent. For homeowners who implemented some of the suggested changes, the actual average energy savings were closer to 17.6 percent.

Residential Equipment

NRCan develops regulations and sets standards for residential equipment performance. As of 2001–2002, products that consume 80 percent of the energy used in the residential sector are regulated under the *Energy Efficiency Act*.

Through labelling and promotion initiatives, NRCan also encourages the manufacture and purchase of more energy-efficient equipment.

Between 1990 and 2000, all common household appliances showed significant increases in energy efficiency. A comparison of the energy efficiency of 1991 and 2001 models of top-mounted, auto-defrost refrigerators shows a dramatic increase in energy efficiency. In 1991, a 25-cubic-foot model used approximately 1200 kWh per year. A 2001 model used approximately 650 kWh.

Between 1990 and 2000, there was a cumulative total energy savings of 531.3 GWh and a reduction of 287.8 kt CO_2e in GHG emissions attributable to this program.

Buildings

Retail and office space account for nearly half of the building sector's energy demands. Schools, health care facilities and hotels and restaurants account for another 35 percent.

Between 1990 and 2000, commercial and institutional energy use increased by 22.1 percent. In 2000, it accounted for 13.0 percent of secondary energy use and 12.6 percent of GHG emissions. However, without improvements in energy efficiency supported by NRCan programs, energy use would have increased by 25 percent.

NRCan's programs address all building types in this sector and target new buildings, existing buildings and equipment.

New Buildings

NRCan provides financial incentives to encourage builders and developers to incorporate energy-efficient features into new construction. In 2001–2002, 63 new contributions totalling more than $4.2 million were issued to builders.

The reduction of GHG emissions realized as a result of incorporating energy-efficient features were significant for all building types participating in the program. The biggest savings among participants came in new office construction, where GHG emissions were reduced by on average 203.17 tonnes per year.

Existing Buildings

NRCan gives commercial businesses and public institutions access to tools and financial assistance to invest in energy efficiency in their existing buildings. More than 700 organizations have made a formal commitment to energy efficiency and reduced GHG emissions.

Between 1998 and 2002, federal financial incentives have totalled $12.8 million, and client investment has totalled $259.7 million. Annual energy savings through these incentives total $32 million.

Equipment

Through its equipment programs, NRCan sets energy efficiency standards and regulations. It also supports the development, testing, deployment and promotion of new technologies.

Products that consume 50 percent of the energy used in the commercial and industrial sector must now meet energy efficiency standards. In 2000, the estimated savings of electricity used for lighting arising from the regulations is 39 petajoules. The resulting net reduction in GHG emissions is estimated at 5.5 megatonnes.

NRCan also develops and distributes building simulation software tools to support advancements in building technology. Architects and engineers use the tools to optimize energy performance. To date, these tools have been used to simulate the energy performance of more than 44 874 houses for NRCan's R-2000 Initiative and EnerGuide for Houses program and 799 buildings for the Commercial Building Incentive Program.

NRCan partners with associations, government and business to develop highly specialized solutions to reduce the energy consumption and GHG emissions of Canadian buildings in a cost-effective manner. The Canadian Centre for Housing Technology is just one joint effort. The centre is co-managed by NRCan, National Research Council Canada and Canada Mortgage and Housing Corporation. In 2001–2002, the Centre tested advanced integrated mechanical systems, a wastewater heat recovery system and electronically commutated motors.

Industry

Energy demand in the industrial sector – forestry, construction and mining, and all manufacturing – accounts for 39.2 percent of secondary energy use and 33.6 percent of GHG emissions.

Between 1990 and 2000, increased industrial activity resulted in a 16.3 percent increase in energy use. Over the same period, industrial GHG emissions increased by only 12.9 percent. Improvements in energy efficiency somewhat mitigated the increase. Without them, the increase in energy use would have been 25 percent higher.

NRCan's programs help industry increase energy efficiency focus on two areas: industrial processes and technologies, and equipment.

Industrial Processes and Technologies

NRCan works with industry at the association level and at the company level, encouraging and supporting industry's efforts to invest in, develop and use more energy-efficient methods and reduce GHG emissions.

In 2001–2002, 24 new companies signed on to be Industrial Energy Innovators and, in total, 126 action plans and progress reports were submitted by participants.

At the sector level, organizations that participated in NRCan's Canadian Industry Program for Energy Conservation (CIPEC) realized significant energy savings. The mean five-year increase in energy consumption for non-participants was 5.2 percent, whereas the increase registered by CIPEC participants was only 2.2 percent.

NRCan also helps industry develop cleaner, more energy-efficient combustion processes. The focus of the research is to optimize the performance of stationary combustion equipment and to develop and evaluate new products, fuels and retrofit technologies.

In 2001–2002, a series of tests was completed on an environmentally benign way of destroying PCB-laden tarry sludge from the tar ponds in Sydney, Nova Scotia.

Since 1991, NRCan has contributed $19 million to 105 projects worth $143 million to support the identification and demonstration of new and emerging energy-efficient technologies.

In 2001–2002, projects included the demonstration of water filtration technology by ZENON Environmental Inc. that uses 80 percent less energy than conventional methods. And Westport Research Inc. undertook a one-year field trial of a low-emissions natural gas engine.

Equipment

Through regulation, standards setting, labelling and research support, four NRCan programs work to improve the energy efficiency of equipment used in industry.

Presently, 50 percent of products used in this sector are covered by Energy Efficiency Standards and Regulations, which set minimum performance standards for equipment. The EnerGuide for Industry program promotes and encourages the manufacture, purchase and use of industrial equipment that is more energy efficient.

In another area, NRCan works to reduce the hazards of mining while increasing energy efficiency. In 2001–2002, testing indicated that the benefits of the new rockdrill include drilling of holes twice as quickly, reduced vibration, dust and noise (15 decibels quieter) and the elimination of oil mist emissions.

Transportation

The transportation sector accounts for more than 28 percent of secondary energy use and more than 34.5 percent of GHG emissions. Passenger and freight, two of the transportation subsectors, account for 56.7 and 39.7 percent, respectively, of transportation energy use. A third subsector, off-road, accounts for the remaining 3.6 percent.

Despite a significant growth in activity variables – primarily increased population and economic activity – transportation energy use increased by just over 21.5 percent between 1990 and 2000. Without improvements in energy efficiency, that increase would have been 39.9 percent.

In 2000, road transport was the biggest user of energy at 77.3 percent. Passenger energy use accounted for 59.7 percent of road transportation and freight energy, 40.3 percent. Because of this extremely high percentage, all NRCan transportation energy-use programs focus on the energy used in road transportation. The programs target four subgroups: personal vehicles, commercial fleets, transportation technology research and development, and alternative transportation fuels.

Personal Vehicles

NRCan's programs encourage manufacturers to meet standards for fuel consumption and improve vehicle fuel efficiency through advancements in technology. Private motorists are encouraged to purchase energy-efficient vehicles. Under a voluntary agreement, manufacturers attach an EnerGuide fuel consumption guide to their cars so that purchasers can make an informed buying decision.

The percentage of new vehicles on car lots with EnerGuide labels increased from 64 percent in 1999 to 77 percent in 2001. In dealership showrooms over the same period, the percentage rose from 47 to 56. In addition, Volvo Cars of Canada was recruited to the EnerGuide for Vehicles program, and all of the companies already involved in the program remained.

Commercial Fleets

In partnership with fleet and industry associations and other levels of government, NRCan delivers information materials, workshops, demonstrations and training to fleet operators to help improve fuel efficiency and encourage the use of alternative fuels in commercial and municipal fleets.

In 2001–2002, NRCan reached an agreement with the Canadian Association of Motive Power Educators for the delivery of the "Fuel Management 101" workshop and development of a data collection strategy to help fleets determine their fuel efficiency and GHG emissions baseline.

Transportation Technology Research and Development

NRCan supports transportation technology research and development on improving vehicle energy efficiency and reducing GHG emissions. Research is underway into the development of low-density and/or high-strength materials for use in transportation applications and of hydrogen fuel cell power to replace diesel in underground mining.

Several coatings for lightweight aluminum heat exchangers were tested. With favourable initial results, testing of heat exchanger prototypes will take place during 2002–2003.

In the mining industry, a prototype locomotive propelled with hydrogen fuel cells (the only one of its kind) has been undergoing surface testing by NRCan since the beginning of 2002.

Alternative Transportation Fuels

NRCan promotes the use and development of alternative fuels – ethanol, natural gas and fuel cells – to minimize environmental impacts.

The estimated amount of fuel ethanol blended into motor gasoline in Canada per year reached 240 million litres in 2001.

The Canadian Transportation Fuel Cell Alliance was launched to develop the fuelling infrastructure for fuel cell vehicles.

Renewable Energy

Renewable energy includes the well-established hydroelectricity industry, which accounts for approximately 58 percent of total electricity generation in Canada. But there are a number of other renewable energy sources and technologies that are emerging in the marketplace or are in development, and these show promise for the long term. NRCan delivers several initiatives to encourage their development and use. Together, all sources of renewable electricity generation reached 68 849 petajoules in 1999, or 62 percent of total capacity.

NRCan's initiatives support education and promotion programs for industry and the public, the development of standards and research. They also provide financial incentives for capacity-building in renewable energy.

Renewable Energy Programs

The Photovoltaic and Hybrid Systems Program has contributed to an average growth in solar photovoltaic applications of 25 percent per year over the last eight years. Installed power capacity in Canada reached 8.1 megawatts in 2001.

In 2001–2002, NRCan contributed more than $1.2 million to 49 projects that were completed under the Renewable Energy Deployment Initiative.

NRCan has also pledged to purchase 20 percent of its electricity from new green power sources by 2010, wherever it makes economic sense.

The Renewable Energy Capacity-Building Program team received the 2001 Head of the Public Service Award for Excellence in Service Delivery. The Program also provided project implementation support to more than 50 potential renewable energy projects at federal and municipal government facilities and in Aboriginal and northern communities.

With ongoing support (dating back to the early 1980s) from NRCan's Renewable Energy Technologies Program, Conserval Engineering Inc. developed SOLARWALL® – the world's most efficient solar air heating system. In 2001–2002, NRCan's new 200-kilowatt indoor solar simulator lamp, the world's largest, opened for business at the National Solar Test Facility. This facility is North America's leading centre for testing and rating technologies under controlled sunlight and temperature conditions.

Community Energy Systems

Through the Community Energy Systems Program, NRCan helped design a heating system for the Cree community of Ouje-Bougoumou in northern Quebec. The system uses sawdust from a local sawmill to provide more than 90 percent of the energy. The resulting reduction in carbon dioxide emissions is estimated to be 2300 tonnes per year.

Federal House in Order

As the country's largest single enterprise, the Government of Canada is working to get its own house in order. It has set as its target a 31 percent reduction in GHG emissions from its own operations by 2010.

The Government of Canada has already achieved a 21 percent reduction since 1990, through building retrofits, better fleet management, downsizing of operations and strategic green power purchases. In 1990, emissions were 3837 kilotonnes. In 2000, emissions were down to 3031 kilotonnes. The Government of Canada will reduce its emissions by a further 12 percent by 2010.

Key departments and agencies that are responsible for 95 percent of Government of Canada GHG emissions have been assigned specific targets under a three-year action plan and must report annually on their progress.

NRCan is providing services and support to these departments and agencies to help them achieve their targets.

Federal Programs

The Federal House in Order initiative activities include GHG inventory and tracking, purchases of emerging renewable electricity, or green power, and efforts to reduce "outside emissions." Under one pilot project launched in October 2002, the opportunity to purchase a transit pass through payroll deduction and at a small discount encourages federal employees to use public transit.

In other programs, NRCan supports efforts to retrofit buildings and other facilities to improve their energy efficiency. This support includes advice and consultation, project financing options and promotion.

In 2001–2002, retrofits of 7000 federal buildings and other facilities were initiated and registered, reducing GHG emissions significantly and generating annual savings of $27 million. In just one example, as of March 2002, the Department of National Defence had invested $104 million and will save an estimated 11.8 terajoules of energy per year.

Targeting heating and cooling systems, NRCan helps federal clients increase energy efficiency, reduce carbon dioxide (CO_2) and nitrogen oxide (NO_x) emissions by encouraging the adoption of new heating and cooling technologies. These technologies could reduce NO_x emissions by 50 percent, increase energy efficiency by up to 15 percent and reduce operating costs by 20 percent, compared with conventional practices. Clients have reduced energy consumption by 800 terajoules, CO_2 emissions by 45 kilotonnes and NO_x emissions by 100 tonnes. Client departments involved in the program have realized incremental improvements in energy efficiency over each year of their involvement. From 2000–2001 to 2001–2002, energy savings as a result of this program increased by 112 terajoules per year, for a total annual savings of 812 terajoules.

Federal vehicles are also targeted under this initiative. NRCan assesses fleets and provides technical advice and encouragement on acquiring and using alternative transportation fuels. Four departments participate in planning and reporting on the initiative: Treasury Board of Canada Secretariat, NRCan, Environment Canada and Public Works and Government Services Canada.

In 2001–2002, an agreement was reached with the Canada Safety Council to include energy efficiency content in the 2002 version of the Defensive Driving Course. The Department of National Defence, the Canadian Food Inspection Agency/Agriculture and Agri-Food Canada and Correctional Service of Canada use this course for all their drivers.

TABLE 1-1

Performance Indicators Highlighted in the Report

Housing

- Average Energy Consumption per Household
- National Trends in Air Leakage in Houses
- Homes Evaluated and Labelled Under the EnerGuide for Houses Program
- Residential Energy Use and Energy Savings per Household
- Average Energy Consumption of New Appliances, 1990 and 2000 Models
- Unit Energy Consumption for Top-Mounted Auto-Defrost Refrigerators Marketed in Canada, 1991 and 2001 Models
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Buildings

- Energy Use in Commercial Buildings, 1999
- Market Penetration of Energy Innovators Initiative in Commercial and Institutional Sectors
- Average GHG Reductions by Institution Under CBIP, 2002
- Energy Innovators Initiative, Incentive Projects from 1998 to 2002

Industry

- Reduction in Energy Use per Unit of Output for Selected Industries, 1990 to 2000
- Industrial Energy Innovators and Action Plans, 1995–1996 to 2000–2001
- Participation in CIPEC Program – Participation Level in Program Elements and Consequences to Energy Consumption

Transportation

- Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards
- Vehicle Fuel Efficiency Awareness

Renewable Energy

- Electricity Generation Capacity from Renewable Sources (Includes Hydro)
- RETScreen® for Business Projects Completed

Federal House in Order

- GHG Emissions Reductions from All Federal Operations
- FBI Investment and Energy Savings
- Energy Savings from FIBP, 1991–1992 to 2001–2002
- Federal Fleet Size and Fuel Consumption, 1995–1996 to 1999–2000
- Purchase of ATF Vehicles for the Federal Fleet

Introduction

Greenhouse Gases and Climate Change

Climate change is a global challenge arising from the continuing buildup in levels of anthropogenic (human-produced) greenhouse gases (GHGs) in the atmosphere, in addition to naturally occurring emissions. GHGs are constituted by a number of gases, but the main source of anthropogenic emissions is carbon dioxide (CO_2) from the combustion of fossil fuels. Substantially reducing GHG emissions is a challenge, particularly given Canada's highly industrialized and resource-based economy. Solutions require a multifaceted, coordinated domestic response and a high level of cooperation among all nations.

In December 1997, Canada and more than 160 other countries met in Kyoto, Japan, and agreed to targets to reduce GHG emissions. Canada's target is to reduce its GHG emissions to 6 percent below 1990 levels by the first commitment period (2008 to 2012).

After signing the Kyoto Protocol, Canada established a National Climate Change Process with provinces, territories, stakeholders and the Canadian public to examine the potential impacts, costs and benefits of the protocol and possible options for its implementation. Currently, the Government of Canada is facilitating comprehensive analytical work and full discussions on these options.

The *Government of Canada Action Plan 2000 on Climate Change* (Action Plan 2000) comprises policies and measures that have significantly increased the scope of funding and activity in the key areas of energy efficiency, technology development and the promotion of alternative energy sources. Announced in October 2000, the Action Plan measures were implemented during 2001–2002.

Natural Resources Canada's Efficiency and Alternative Energy Program

Over the past decade, Natural Resources Canada's (NRCan's) emphasis has been to promote energy efficiency and the use of alternative energy as a means to reduce GHG emissions, particularly in relation to the Kyoto Protocol. Improving energy efficiency reduces greenhouse gas emissions that contribute to climate change. NRCan's Efficiency and Alternative Energy (EAE) program was launched in 1991. A complete list of NRCan's EAE initiatives and expenditures in 2001–2002 are listed in Appendix 1. These initiatives engage Canadian society and all major sectors of the economy in new and more efficient approaches to secondary energy use – i.e., the consumption of energy in the residential, commercial and institutional, industrial and transportation sectors.

NRCan's EAE initiatives are managed by

- the Office of Energy Efficiency (OEE), which delivers market transformation initiatives to improve energy efficiency and the use of alternative transportation fuels;
- the CANMET Energy Technology Centre[1] and the Mineral Technology Branch, which deliver EAE research and development (R&D) initiatives;
- the Energy Resources Branch, which delivers market transformation initiatives for renewable energy; and
- the Science Branch of the Canadian Forest Service, which undertakes R&D in the use of forest biomass for energy.

[1] CANMET is the Canada Centre for Mineral and Energy Technology.

In its efforts to reduce GHG emissions, NRCan emphasizes partnership and cooperation with stakeholders such as other levels of government, the private sector and non-governmental organizations. Using this approach, the demand side of the energy market moves toward more energy-efficient capital stock, production processes and operating practices without reducing service or comfort levels. On the supply side, Canada participates in developing technology for tapping renewable energy resources and alternative transportation fuels as well as increasing the energy efficiency of production.

In This Report

This ninth annual Report to Parliament focuses principally on EAE initiatives that address secondary energy use. Chapter 1 provides the policy context and strategic overview. Trends in energy use and GHG emissions in Canada are discussed in Chapter 2. Chapter 3 summarizes work undertaken during the reporting period to improve the quality and coverage of performance indicators for the initiatives described in Chapters 4 through 9. Chapters 4 to 7 review individual EAE initiatives to improve energy use in housing, buildings, industry and transportation, highlighting their achievements and progress indicators. Chapter 8 deals with renewable energy sources and use as well as an initiative in energy efficiency and renewable energy in Canadian communities. Chapter 9 describes the Government of Canada's actions to improve its own use of energy. The final chapter describes intergovernmental cooperation in EAE.

Chapter 1: Policy Context and Legislation

Federal Policy and Programs on Energy Efficiency and Alternative Energy

Energy use has been a policy concern since the 1970s when governments responded to the oil crises of 1973 and 1979 by promoting energy conservation and renewable energy sources. By the mid-1980s, world oil supply had become sufficiently abundant that governments deregulated energy prices and markets and phased out most energy conservation and renewable energy programs.

Toward the end of the 1980s, individuals, organizations and governments around the world became concerned that greenhouse gas (GHG) emissions produced by burning fossil fuels – such as coal, oil and natural gas – could contribute to climate change.

In 1990, Canada's concern about its GHG emissions (which result mostly from energy use) spurred an expansion of federal programs designed to improve energy efficiency and increase the use of alternative energy sources. The ongoing Efficiency and Alternative Energy (EAE) program was launched by Natural Resources Canada (NRCan) in 1991 to support economically feasible improvements in energy efficiency and the use of alternative energy sources. It encourages investment in corporate and consumer EAE opportunities and seeks to engage all sectors of the economy and Canadian society in rethinking and improving energy use. The EAE program uses a variety of policy instruments, including leadership, information, voluntary actions, financial incentives, research and development (R&D) and regulation. In all cases, it emphasizes partnership with stakeholders, such as other levels of government, the private sector and non-governmental organizations.

In this manner, the program helps the demand side of the energy market move toward more energy-efficient capital stock, production processes and operating practices without reducing service or comfort levels. On the supply side of the market, the program ensures that Canada participates in the development of technology for tapping renewable energy sources, using alternative transportation fuels and increasing the energy efficiency of the production of energy.

The EAE program has provided a foundation for long-term processes that respond to evolving environmental and economic development priorities. Since 1991, a number of major developments have affected NRCan's EAE policies and programs.

In 1992, Canada signed and ratified the *United Nations Framework Convention on Climate Change*. Under this convention, Canada and other countries agreed to work to stabilize GHG emissions at 1990 levels by 2000. In 1995, federal and provincial ministers of energy and the environment approved the National Action Program on Climate Change (NAPCC), which included as a key strategic element the promotion of energy efficiency in all sectors of the economy. At the same time, to broaden awareness of the need to act and reinforce the impetus to voluntary action, they also agreed to establish the Climate Change Voluntary Challenge and Registry (VCR). It was incorporated in October 1997 as a non-governmental, not-for-profit organization. Canada's Climate Change Voluntary Challenge and Registry Inc. (VCR Inc.) invites Canadian companies and organizations to develop action plans to limit their net GHG emissions and to file these, as well as progress reports and achievements, on its public registry.

The federal budget of February 1997 provided $60 million over three years for new initiatives to improve energy efficiency in new commercial buildings; encourage commercial building retrofits; provide for energy performance assessments of houses; and stimulate demand for cost-effective, commercially available renewable energy systems for space and water heating and cooling. This funding was renewed in the February 2000 federal budget.

In December 1997, at the third Conference of the Parties to the Framework Convention on Climate Change held in Kyoto, Japan, participating countries agreed to reduce GHG emissions from 1990 levels within the period 2008 to 2012. Canada pledged to reduce its emissions by 6 percent. The protocol will enter into force when at least 55 parties to the Framework Convention, representing 55 percent of industrialized countries' GHG emissions, have ratified it.

In February 1998, the federal budget provided $150 million over three years for a Climate Change Action Fund (CCAF) to help Canada develop its response to the Kyoto Protocol. This funding was renewed in the February 2000 federal budget. The fund has the following four components:

- *Public Education and Outreach* builds public awareness and understanding of climate change and encourages action to reduce GHG emissions;
- *Technology Early Action Measures* (TEAM) shares with the private sector the risk of demonstrating cost-effective technology projects that will lead to reductions in GHG emissions;
- *Science, Impacts and Adaptation* supports research to advance our knowledge of the magnitude, rate and regional distribution of the impacts of climate change on Canada and supports the development of adaptation strategies; and
- *Foundation Analysis* supports the National Climate Change Process and the analysis of options for reducing Canada's GHG emissions.

In early 1998, the federal, provincial and territorial governments established the National Climate Change Process to examine the impact, costs and benefits of the Kyoto Protocol and the implementation options open to Canada. From spring 1998 to winter 1999–2000, the process engaged more than 450 experts from across Canada, and their recommendations were provided to governments in fall 2000. During the reporting period, the Government of Canada issued the *Discussion Paper on Canada's Contribution to Addressing Climate Change* and commenced consultations with stakeholders. NRCan officials have provided a great deal of support, analysis, advice and guidance to the National Climate Change Process.

In January 2000, federal, provincial and territorial ministers of energy and the environment announced the Baseline Protection Initiative (BPI) as one of the first major policy initiatives to be taken under Canada's National Implementation Strategy on Climate Change. It is designed to remove possible disincentives to early actions to reduce GHG emissions by allowing organizations to reconstruct their emissions baselines to reflect the impact of actions taken since January 1, 1990.

In addition to the previously noted renewal of funding for four EAE initiatives and the CCAF, the federal 2000 budget also provided funds for a Green Municipal Enabling Fund (GMEF) and a Green Municipal Investment Fund (GMIF). The Federation of Canadian Municipalities manages the two funds under agreements with NRCan and Environment Canada. The GMEF is a $25-million endowment, available for five years, to contribute to feasibility studies of energy and environmental projects in municipal operations. The GMIF is a permanent, $100-million endowment to provide loans and loan guarantees to eligible recipients to carry out energy and environmental projects. It also provides grants and long-term loans for pilot projects that demonstrate innovative technologies and processes.

Building on a successful initial purchase of green power in Alberta, the February 2000 federal budget expanded the pilot initiative to permit the procurement of $15 million in renewable energy over the next 10 years for federal facilities in Saskatchewan and Prince Edward Island.

In October 2000, the Government of Canada announced its *Action Plan 2000 on Climate Change*, representing its contribution to *Canada's First National Climate Change Business Plan* being developed with the provinces and territories. Funding of $500 million over five years began in 2000–2001.

Responsibility

In April 1998, NRCan's Office of Energy Efficiency (OEE) was established, with a mandate to strengthen and expand Canada's commitment to energy efficiency, in particular to help address the challenges of climate change. The OEE's programs target all final energy consumers and emphasize partnerships and economic investment. Its program objectives are to overcome the market barriers posed by inadequate information and knowledge about energy efficiency and alternative transportation fuels, and to address institutional deterrents in energy-use markets and economic constraints that energy users face. The OEE is also responsible for identifying opportunities for new and heightened energy efficiency measures. The National Advisory Council on Energy Efficiency assists in this work by providing advice and guidance to the OEE. The council comprises energy efficiency experts and leaders from all sectors of the economy.

NRCan's Office of Energy Research and Development (OERD) coordinates and funds non-nuclear, energy-related R&D for the Government of Canada in partnership with 12 federal departments and agencies. As a response to climate change, the OERD, through the Program of Energy Research and Development (PERD), dedicates more than 50 percent of its annual $58-million R&D budget to study options related to energy efficiency and alternative energy. In addition, PERD directs funding toward studies aimed at understanding climate change and developing mitigation or adaptation options related to it.

NRCan's CANMET Energy Technology Centre (CETC) focuses on technology development and deployment. Technology development activities are performed on a cost-shared basis either through in-house R&D work at its laboratories or by providing funding support to its technology partners. CETC-Ottawa, in Ontario, works in partnership with a range of stakeholders to develop and disseminate innovative, cleaner energy technologies, including energy-efficient technologies for homes, businesses and industry; renewable energy; alternative transportation fuels; district heating and cooling systems; advanced low-emissions combustion technologies; and energy-efficient metallurgical fuel products and technologies. CETC-Varennes, in Quebec, develops technologies that use energy wisely and help Canadians stay competitive in the marketplace, such as advanced drying technologies, heat transfer and storage systems, photovoltaics, renewable energy for remote communities and related software tools such as RETScreen® International.

The Energy Resources Branch (ERB) is the fourth organization within NRCan's Energy Sector reporting on programs in this document. Within the ERB, the Renewable and Electrical Energy Division promotes the development of a sustainable renewable energy industry in Canada. It promotes investments in renewable energy systems for heating and cooling and provides information on renewable energy technologies. By strengthening markets for the renewable energy industry, its programs contribute to GHG reductions, job creation and export sales.

Energy Efficiency Strategy

Most of NRCan's EAE initiatives deal solely with energy efficiency. Their goal is to improve energy efficiency by

- increasing the energy efficiency of new and existing buildings, equipment, systems and vehicles;
- persuading individuals and organizations to purchase buildings, equipment, systems and vehicles that are more energy efficient;
- ensuring that energy-consuming equipment is used in the most energy-efficient way;
- influencing the energy-use practices of individuals and organizations; and
- developing technologies to give consumers, industry and communities new opportunities to improve energy efficiency.

Alternative Energy Strategy

In the short term, energy efficiency improvements can contribute significantly to energy savings and environmental objectives. In the long term, however, reducing GHG emissions to 1990 levels or below will require greater use of alternative energy sources.

Alternative energy includes renewable sources other than large hydro-electric facilities, new applications of conventional sources and new fuels such as hydrogen for fuel cells. (Large hydro is not considered an alternative energy source because it is already a successful, well-established mode of energy production, supplying more than 60 percent of the electricity in Canada.) Some technologies, especially those that involve the use of forestry biomass and propane and natural gas in vehicles, are already commercially available and accepted. Some have found applications in specialized markets, such as remote communities. Other technologies are still in the early stages of development.

Federal initiatives are helping to expand the infrastructure (e.g., fuelling stations) for the sale of alternative transportation fuels, especially in urban areas where the provision of infrastructure is more economic. R&D focuses on ways to improve options in the use of these fuels.

NRCan supports R&D to reduce costs, improve performance, develop safety and performance standards and increase the scope of renewable energy technologies. The department also provides incentives for investments in renewable energy systems and purchases of electricity generated from renewable sources, disseminates information to consumers, and assesses economic and environmental aspects of renewable sources of energy.

Policy Instruments

NRCan's key policy instruments are

- leadership;
- information;
- voluntary initiatives;
- financial incentives;
- regulation; and
- research and development.

Leadership

Leadership means setting an example for other levels of government and for the private sector by increasing the energy efficiency and use of alternative energy in the Government of Canada's operations.

Information

NRCan disseminates information to consumers, using methods that range from broad distribution to individual consultations with clients. These activities include publications, exhibits, advertising, toll-free lines, conferences, Web sites, workshops and promotional products. NRCan's wide range of marketing and communications activities aim to

- increase awareness among Canadians of the environmental impact of energy use; and
- encourage consumers to increase the efficiency of their energy use and to switch to alternative sources of energy.

Voluntary Initiatives

Companies and institutions work with NRCan on a voluntary basis to establish and achieve energy efficiency objectives. NRCan's voluntary EAE initiatives target large consumers of energy in the commercial, institutional and industrial sectors and organizations whose products are important determinants of energy use. In a typical initiative, an organization agrees to take steps that will save money and reduce environmental impacts. The initiatives involve industry, government

agreements and, for groups of large industrial energy users, energy efficiency target setting. NRCan provides a variety of support services to assist and stimulate action by companies and institutions on energy efficiency, including developing standards and training.

Financial Incentives

NRCan uses financial incentives to encourage final users of energy to employ energy efficiency and renewable energy technologies and practices when they acquire, design or build new buildings or retrofit existing ones. NRCan also offers financial incentives for wind energy and for natural gas vehicles and refuelling infrastructure.

Regulation

Regulation involves setting energy performance levels and labelling requirements for certain types of equipment and working with provincial governments to improve the energy efficiency provisions in Canadian building codes.

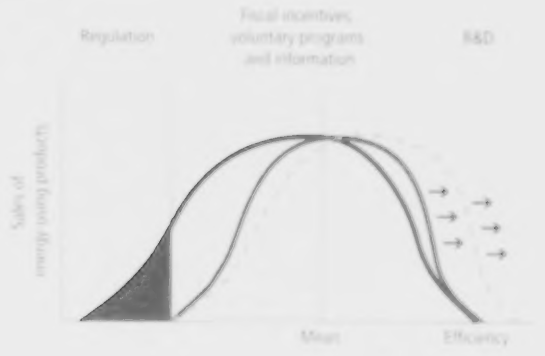
The *Energy Efficiency Act* gives the Government of Canada the authority to make and enforce regulations concerning EAE, primarily performance and labelling requirements for energy-using products (as well as doors and windows) that are imported or shipped from province to province. The Act also gives the Government of Canada the authority to establish regulations and to collect statistics and information on energy use and alternative energy.

Research and Development

NRCan's EAE initiatives support the development and dissemination of more energy-efficient equipment, processes and technologies and alternative energy technologies. R&D also provides the scientific knowledge needed to develop the technologies, codes, standards and regulations required for the sustainable use of energy.

FIGURE 1-1

Moving the Market



NRCan provides national leadership in energy science and technology (S&T) by undertaking in-house research in its own laboratories, by contracting out research activities to other organizations and through the federal PERD. PERD and TEAM are the only federal interdepartmental S&T investment funds that focus on the energy sector and its economic and environmental effects.

Figure 1-1 shows how these policy tools work together to increase energy efficiency, i.e., how they help to reduce the amount of energy needed to obtain a certain level of service.

Chapter 2: Trends in Energy Use

Introduction

Canadians enjoy an abundance of energy from a variety of sources. This comparative advantage in the supply of energy has helped Canadians deal with the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate. It also has favoured the development of industries that have a particularly strong energy demand. As a result, Canada consumes more energy per capita than most countries.

Canadians spend almost $104 billion per year on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. This represents almost 10 percent of the country's gross domestic product.

Energy Use and Greenhouse Gas Emissions

We typically speak of two types of energy use: primary and secondary. Primary energy use encompasses the total requirements for all users of energy, the energy required to transform one energy form to another (e.g., coal to electricity) and the energy used to bring energy supplies to the consumer. Secondary energy use is energy used by final consumers for residential, agricultural, commercial, industrial and transportation purposes.

Primary energy use in Canada today reflects changes over several decades in energy-consuming equipment and buildings and in the behaviour of energy users. Primary energy use increased by more than 19.5 percent between 1990 and 2000, from 9724 petajoules to 11 621 petajoules.

Secondary energy use (8164 petajoules) accounted for 70.3 percent of primary energy use in 2000. It was responsible for about 65.6 percent (474 megatonnes) of total greenhouse gas (GHG) emissions in Canada, if we include indirect emissions – namely, those produced by electric utilities to meet end-use electrical demand.

This report deals with energy-related GHG emissions, which comprise carbon dioxide (CO_2), methane and nitrous oxide. CO_2 represents the majority of Canada's GHG emissions. All subsequent references in this report to CO_2 and GHGs include both emissions that are attributable directly to secondary energy use and indirect emissions attributable to electricity generation.

From 1990 to 2000, secondary energy use increased by 16.7 percent. GHG emissions attributable to secondary energy use increased by only 16.3 percent because of a 0.3 percent decrease in the GHG intensity of energy users. This reflects changes in the fuel mix. By 2000, the oil share of secondary energy use had fallen by 1.2 percentage points from 1990 levels, from 41.2 to 40.0 percent, and the natural gas share increased from 25.4 to 26.1 percent. The electricity share was stable, and the share of other fuels, mainly biomass, increased.

The industrial sector is the largest energy user, accounting for 39.2 percent of total secondary energy use in 2000. The transportation sector is the second-largest energy user at 28.0 percent, followed by the residential sector at 17.0 percent, the commercial and institutional sector at 13.0 percent and the agriculture sector at 2.8 percent.

Energy Efficiency

NRCan annually publishes *Energy Efficiency Trends in Canada*, which reports on changes in energy use (and GHG emissions) since 1990 and the contribution of the following key factors to these changes:

- increases in sector *activity* lead to increased energy use and emissions. In the residential sector, for example, an increase in the number of households has the effect of increasing energy use;
- a shift in the *structure* of activity toward more energy-intensive components of activity leads to increased energy use and emissions. For example, if the distribution of activity in the industrial sector shifts from forestry to the iron and steel industry, industrial energy use will increase because the former sector is less energy intensive than the latter;
- fluctuations in *weather* lead to changes in space-heating and cooling requirements. A colder winter or a warmer summer can lead to increased energy use; and
- *energy efficiency* – the amount of energy used to provide a given level of service.

In this report, changes in energy efficiency are the net result after allowing for the changes in energy use due to changes in activity, structure and weather. To the extent that other factors that affect energy use have not been captured, this measure of energy efficiency improvement might overstate or understate the "actual" change. For example, in the industrial sector, there may have been changes in energy use due to shifts in the mix of products, but this is not captured.

Secondary energy use increased by 16.7 percent between 1990 and 2000 (from 6999 to 8164 petajoules). Two factors contributed to this increase (see Table 2-1):

- activity (economic growth) raised secondary energy use by 26.4 percent (1845 petajoules); and
- changes in the structure of activity decreased secondary energy use by 1.5 percent (108 petajoules).

A third factor – weather – increased secondary energy use by 0.6 percent (40 petajoules), reflecting the extent to which the winter of 2000 was colder than the winter of 1990.

If only these three factors had been in effect, secondary energy use would have increased by 25.4 percent. However, improvements in energy efficiency worked to decrease energy use by 9.4 percent (661 petajoules).

TABLE 2-1

Explanation of Changes in Secondary Energy Use, 1990 to 2000

	Sectors						
	Residential	Commercial-Institutional	Industrial	Transportation	Agriculture	Total	% Change
1990 energy use (PJ)	1300	867	2755	1878	199	6999	
2000 energy use (PJ)	1388	1059	3204	2282	232	8164	
Change in energy use (PJ)	88	192	449	404	33	1166	16.7
Explanatory Factor (change due to)							
Activity	224.7	205.4	1004.7	410.3		1845.1	26.4
Structure	28.6	2.9	-316.7	177.5		-107.7	-1.5
Weather	31.6	8.3	N/A	N/A		39.9	0.6
Energy efficiency (PJ)	-196.6	-23.2	-239.2	-201.9	0	-660.8	-9.4
Other factors		-1.6		18.3	32.8	49.5	0.7

As a result, energy use increased by only 16.7 percent. This change in energy use during 1990–2000, with and without changes in energy efficiency, is shown in Figure 2-1. The difference in energy use due to energy efficiency – the energy saving – represents a reduction in energy costs of $8.7 billion a year and a reduction in GHG emissions of over 38 megatonnes.

Changes in energy efficiency are estimated for each of the four major end-use sectors and presented in Chapters 4 to 7. The energy efficiency improvements were largest in the residential sector (15.1 percent), followed by the transportation (11.3 percent), industrial (8.7 percent) and commercial and institutional sectors (2.7 percent).[2]

FIGURE 2-1

Secondary Energy Use and Energy Savings Due to Energy Efficiency, 1990 to 2000

Renewable Energy

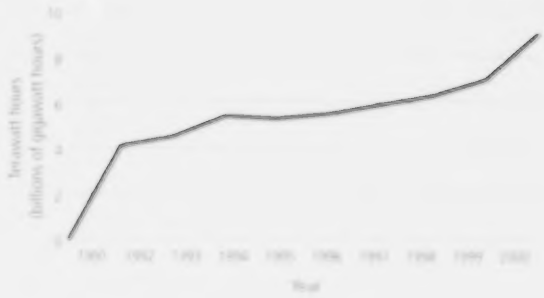
As previously noted, changes in the fuel mix employed by the Canadian economy can reduce GHG intensity. Although in the near term this can be achieved by moving from more- to less-GHG-intensive fuels (e.g., from coal to natural gas), over the longer term the use of renewable energy sources is expected to accelerate this trend.

Figure 2-2 shows the trend in the use in Canada of electricity generated from wind, solar and biomass, indicating a 140 percent increase over the period 1991 to 2000. Although representing only a small component of overall electricity use, the proportion of electricity generated from these renewable energy sources increased from 1.1 to 1.6 percent over the period, representing a 45 percent increase in its share. Most of this production was derived from biomass.

The graph does not include hydro sources, either conventional or small (less than 20 megawatts). The former accounts for about 60 percent of electricity generated in Canada; installed capacity is over 67 gigawatts. There are over 230 small hydro installations in Canada, with a total capacity of about 1500 megawatts.

FIGURE 2-2

Net Solar, Wind, Wood and Waste Electric Power Consumption in Canada



[2] The aggregate energy use data presented in this report are taken from Statistics Canada's *Quarterly Report on Energy Supply–Demand in Canada* (QRESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of QRESD energy use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report uses a definition better suited for the purpose of energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix A of Natural Resources Canada's *End-Use Energy Data Handbook 1990–2000*.

Chapter 3: Measuring Progress

Background

The primary goal of Natural Resources Canada's (NRCan's) Efficiency and Alternative Energy (EAE) initiatives is to change energy consumption patterns to obtain environmental and economic benefits. Part of assessing program progress and program performance involves considering program delivery and program effectiveness.

In the past, NRCan has focused on the monitoring and tracking of the following three aspects of program delivery:

- program outputs;
- program outcomes; and
- market outcomes.

Program outputs are the items that a program produces regularly, such as information and marketing materials, demonstration projects, financial incentives and regulations. Program outputs are designed to lead to *program outcomes* – namely, changes in the behaviour of groups targeted by a program. These groups may be either energy users or producers of energy-using equipment or structures. For example, program outcomes occur when consumers purchase appliances that are more energy efficient than they would have purchased if there had been no program. Other important factors that influence consumer behaviour include product price, household income, personal taste and other government and non-government programs.

Because program outcomes can directly affect the amount and type of energy consumed in the market, they contribute, in part, to observable *market outcomes*. Market outcomes ultimately reflect the impacts of NRCan programs on changes in energy efficiency, energy intensity, greenhouse gas (GHG) emissions and the use of alternative energy. In this sense, achievement of a targeted market outcome, or observable progress toward a market outcome, serves as an indicator of program effectiveness. An example of a program outcome that leads to a market outcome is a householder's purchase of a more energy-efficient appliance and reduced use of electricity. Depending on the source of electricity, and how the utility changes its electricity-generating methods to meet the change in demand that results from reduced electricity use, this could also lead to a decline in GHG emissions.

A Renewed Focus on Results

More recently, a government-wide initiative aimed at "managing for results" has encouraged management in all federal departments and agencies to focus more on the impacts and effects of their programs and services on the lives of Canadians. Managing for results requires more than just monitoring program delivery; it means clearly defining the results to be achieved, an increased emphasis on program and market outcomes, measuring and evaluating program performance and making adjustments to improve both the efficiency and effectiveness of programs. It also means reporting on performance in ways that make sense to Canadians.

Measuring program and market outcomes can be time-consuming, costly and difficult. In particular, quantifying program outcomes requires client and data surveys and detailed analyses of energy use. NRCan's National Energy Use Database (NEUD) initiative helps the department track changes in energy consumption at a disaggregated level. Still, it is difficult to determine the incremental effects of programs because other factors, such as variation in energy prices, also influence these effects. Moreover, because several factors and programs can influence a consumer at the same time, it is difficult to determine the separate contribution of each factor and program to the total effect. Consequently, quantifying program outcomes, impacts and, ultimately, results also requires some knowledge of attribution – or the proportion of the observed or estimated market outcome that can be reasonably attributed solely to program activities and efforts.

This report uses a mix of progress indicators, which are quantitative where possible. The challenge for NRCan is to continuously improve the coverage and quality of these progress indicators, both in general and to ensure that they increasingly reflect a focus on results. The following page highlights some of NRCan's more recent and current efforts to improve the quality of its program performance information.

2001–2002 Highlights of the Office of Energy Efficiency's Program Attribution Research

In the last year, the Office of Energy Efficiency (OEE) completed impact attribution studies for two of its programs – the Canadian Industry Program for Energy Conservation (CIPEC) and EnerGuide for Equipment. Both of these studies employed analytical methods derived from discrete choice theory, which the private sector has used to estimate the change in behaviour that can occur (for either an individual or a group of individuals) as a result of a firm's marketing efforts or a utility's program efforts. Discrete choice theory methods are only beginning to be applied to the evaluation of public sector programs. Both studies were aimed at estimating the market outcomes of the programs, measured in terms of energy savings and GHG emissions reductions that could be attributed solely to program efforts. The studies yielded positive and insightful results that not only allow managers to gauge the effectiveness of their programs, but also allow the programs to be strategically improved to ensure even better outcomes in the future.

The CIPEC study revealed that the average five-year increase in energy consumption, adjusted for extraneous factors such as weather, changes in business size and production, was 2.4 times lower for program participants than for non-participants. The impact of the program was even greater for specific energy-using systems. For example, program participants experienced no net change in the adjusted five-year average energy consumption of their boiler systems, whereas CIPEC non-participants saw the adjusted five-year average energy consumption of their boiler systems increase by almost 7 percent. Refer to Chapter 6 for more highlights of CIPEC's recent achievements.

The EnerGuide for Equipment study also showed that the program was having a positive impact on its target market. More specifically, the study revealed that the presence of the EnerGuide label helped sell more higher-efficiency residential appliances between 1990 and 2000 than would otherwise have been sold in the absence of program efforts. Estimated electricity savings and GHG emissions reductions due to the labelling program total about 530 gigawatt hours per year and 288 kilotonnes of GHGs, respectively, for the period 1990 to 2000. Refer to Chapters 4 to 7 for more study results and more highlights of this program's recent achievements.

The OEE is now undertaking further analysis to determine the impacts of its other programs and anticipates completing at least two more similar studies in the coming fiscal year. The OEE will continue to report on the progress of its performance assessment work in the coming years.

Chapter 4: Housing

Energy Use and Greenhouse Gas Emissions

The residential sector includes four major types of dwellings: single detached, single attached, apartments and mobile homes. Energy is used in dwellings for space heating and cooling, heating water and operating appliances and lights. This sector accounts for 17.0 percent (1388 petajoules) of secondary energy use and 15.8 percent (75 megatonnes) of greenhouse gas (GHG) emissions.

Most dwellings in Canada are single detached houses, followed by apartments, single attached dwellings and mobile homes (see Figure 4-1). Because single detached and attached houses predominate, most Natural Resources Canada (NRCan) residential building programs focus on these dwellings.

Space and water heating make up 81.6 percent of residential energy use, followed by the shares devoted to operating appliances, lighting and space cooling (see Figure 4-2).

Between 1990 and 2000, residential energy use increased by 6.8 percent, or 88 petajoules (from 1300 to 1388 petajoules). From 1990 to 2000, GHG emissions from the residential sector increased by 7.3 percent. A 6.8 percent increase in energy use combined with a 7.3 percent increase in GHG emissions reflects an increase in GHG intensity. This was principally due to an increase in the carbon intensity of electricity.

Four main factors tended to influence residential energy use – activity, weather, structure and energy efficiency:

- activity – the increase in the number of households and the size of dwellings (the principal measures of residential activity) increased energy use by 17.3 percent (225 petajoules);
- weather – colder weather in 2000 compared with 1990 led to an increase in space-heating requirements. This increased energy use by 2.4 percent (32 petajoules);

FIGURE 4-1

Canadian Households by Type of Dwelling, 2000

FIGURE 4-2

Residential Energy Use by Purpose, 2000

- structure – the percentage shares of energy end-uses changed over the period such that they increased energy use by 2.2 percent (29 petajoules); and
- energy efficiency – improvements in energy efficiency worked to decrease energy use by 15.1 percent (197 petajoules).

Growth in residential energy use was driven in large part by growth in activity. This increase was partially offset by significant improvements in energy efficiency. Structural changes had a minor impact on residential energy use.

The change in residential energy use from the years 1990 to 2000, as well as the energy savings due to energy efficiency, is shown in Figure 4-3.

NRCan delivers initiatives to increase energy efficiency in the following residential subsectors:

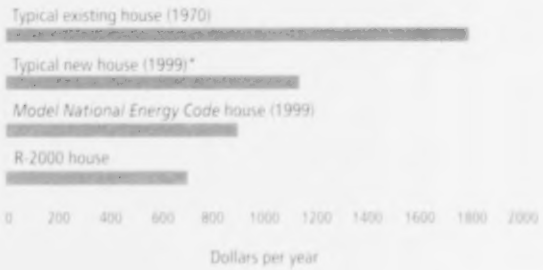
- new houses;
- existing houses; and
- residential equipment, including
  - energy performance regulations; and
  - energy labelling.

FIGURE 4-3

Residential Energy Use and Energy Savings Due to Energy Efficiency, 1990 to 2000

FIGURE 4-4

Annual Heating Costs for Houses Constructed to Different Standards, 1999


Typical existing house (1970)
Typical new house (1999)*
Model National Energy Code house (1999)
R-2000 house
0 200 400 600 800 1000 1200 1400 1600 1800 2000
Dollars per year

*198-m² single detached house heated with natural gas, Ottawa, Ontario

FIGURE 4-5

Average Energy Consumption per Household (EnerGuide for Houses Program and R-2000 Initiative)

New Houses: **R-2000* Standard**

Objective: To increase market adoption of energy-efficient new houses by promoting changes in construction practices.

The R-2000 Initiative encourages Canadians to build houses that are more energy efficient and that are environmentally friendly and healthy to live in. Trained and licensed R-2000 homebuilders and other professionals commit to meeting the R-2000 Standard – a technical performance standard that exceeds the requirements for energy efficiency and environmental responsibility in current Canadian building codes.

Key 2001–2002 Achievements

- 100 percent of the 140 active builders and over 20 new builders and professionals were trained to the revised R-2000 Standard.

For more information:
oee.nrcan.gc.ca/r-2000/english/index.cfm

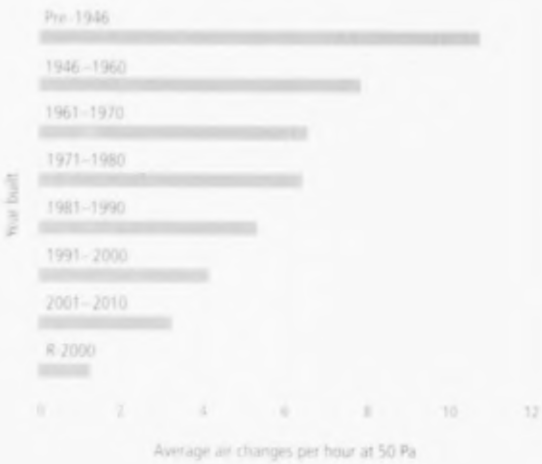
*R-2000 is an official mark of Natural Resources Canada.

FIGURE 4-6

R-2000 Share of National Housing Completions, 1990 to 2000

FIGURE 4-7

National Trends in Air Leakage in Houses



New Houses: Super E™ Program

Objective: To export energy-efficient, durable and environmentally friendly Canadian housing technology to foreign builders.

The Super E™ Program is a strategic housing export initiative delivered by NRCan as part of the Team Canada export strategy. Launched in 1998, the Super E™ initiative involves partnerships between government and industry. The first Super E™ houses were built in Japan.

- The Canadian R-2000 housing concept has been adapted to international markets through Super E™ and now has broad acceptance. To date, in Japan, 54 houses have been built; in the United Kingdom, one is complete and 31 are under construction.
- Over 15 Canadian companies from British Columbia to Prince Edward Island are partnered with over 40 foreign companies in Japan and the United Kingdom.

Key 2001–2002 Achievements

- Working with a Canadian builder, a U.K. builder and the Canada Mortgage and Housing Corporation, the Super E™ program was brought to the United Kingdom, and the first house opened. Additional partnerships between Canadian and U.K. interests in England, Scotland and Ireland are underway. The Super E™ U.K. initiative resulted in the establishment of a partnership with Zurich Insurance Company of the United Kingdom.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

Existing Houses: **EnerGuide for Houses**

Objective: To encourage Canadians to improve the energy efficiency of their homes.

The EnerGuide for Houses Program provides Canadians with the facts they need to improve the energy efficiency of their homes, especially when undertaking home renovation and maintenance projects. The program offers homeowners personalized expert advice on how to improve the energy performance of their houses.

Key 2001–2002 Achievements

- NRCan signed contracts with 15 delivery agents to cover 80 percent of the Canadian population.
- Average annual energy savings for homes that underwent some retrofit activities was 17.6 percent.

For more information:
oee.nrcan.gc.ca/houses-maisons

FIGURE 4-8

Homes Evaluated and Labelled Under the EnerGuide for Houses Program

Under the EnerGuide for Houses Program, homes are evaluated to determine the potential for energy savings (an A evaluation). After renovations implementing program recommendations have taken place, some homes are revisited to determine the actual energy savings (a B evaluation).

FIGURE 4-9

Residential Energy Use and Energy Savings per Household

Residential Equipment: Energy Efficiency Standards and Regulations

Objective: To eliminate the less energy-efficient models of energy-using equipment from the market through minimum performance regulations under the *Energy Efficiency Act*.

The Regulations incorporate national consensus performance standards that include testing procedures to determine the energy performance of the equipment. They prohibit imports of, or interprovincial trade in, prescribed products that fail to meet minimum energy-performance levels and labelling requirements.

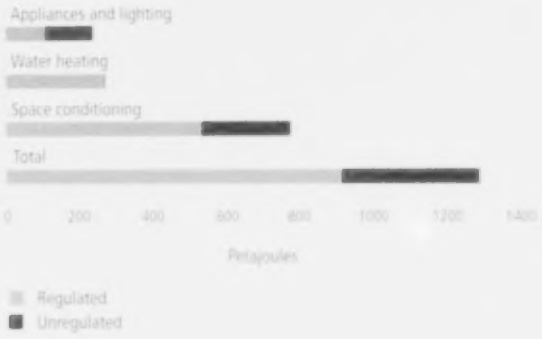
Key 2001–2002 Achievements

- The Regulations cover products that consume 80 percent of the energy used in the residential sector and 50 percent in the commercial-institutional sector.

For more information:
oee.nrcan.gc.ca/regulations

FIGURE 4-10

Share of Residential Energy Consumption Subject to *Energy Efficiency Regulations*, 1999



Residential Equipment: Labelling and Promotion

Objective: To promote the production, purchase and use of more energy-efficient major electrical household appliances, as well as heating, ventilating and air-conditioning (HVAC) equipment.

The Labelling and Promotion program uses labelling, rating and promotional activities to encourage manufacturers to produce, and consumers to purchase and use, more efficient energy-using equipment. The program is made up of EnerGuide for Equipment, which provides comparative information on the energy performance of major household appliances and HVAC equipment, and the ENERGY STAR® initiative, which allows the consumer to identify the most energy-efficient products available based on a standard set of criteria.

Key 2001–2002 Achievements

- Over 32 energy-using products are regulated for their minimum energy performance.

For more information:
oee.nrcan.gc.ca/energuide
or
oee.nrcan.gc.ca/equipment

FIGURE 4-11

EnerGuide Label for Appliances

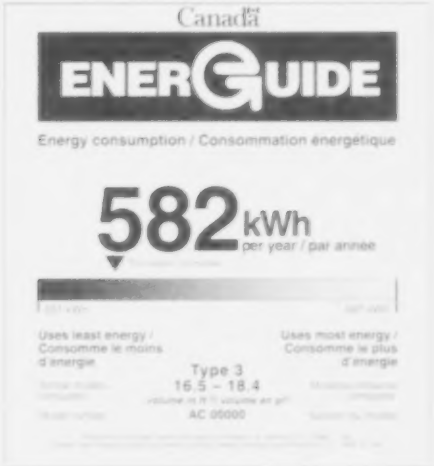


FIGURE 4-12

EnerGuide Label for Air Conditioners

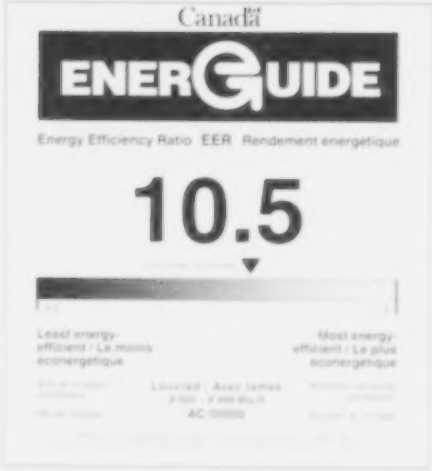


FIGURE 4-13

Average Energy Consumption of New Appliances, 1990 and 2000 Models

FIGURE 4-14

Unit Energy Consumption for Top-Mounted Auto-Defrost Refrigerators Marketed in Canada, 1991 and 2001 Models

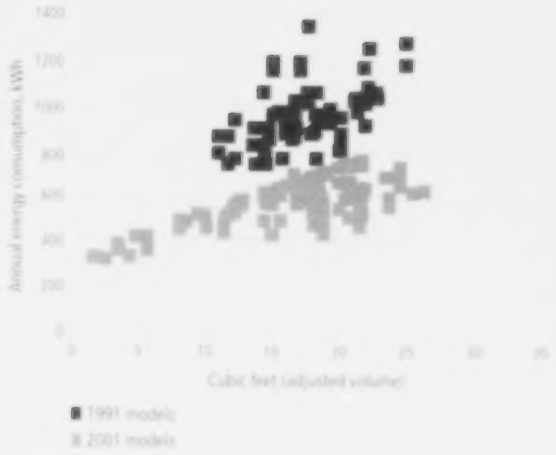


FIGURE 4-15

Total Energy Savings and GHG Emissions Reductions Attributable to the EnerGuide for Equipment Program, 1990 to 2000

Chapter 5: Buildings

Energy Use and Greenhouse Gas Emissions

The commercial and institutional sector includes activity related to trade, finance, real estate, public administration, education and commercial services, including tourism. This sector uses energy mainly for space and water heating, space cooling, lighting, motive power for services such as pumping and ventilation in buildings, and street lighting.

In 2000, the commercial and institutional sector accounted for 13.0 percent (1059 petajoules) of secondary energy use and 12.6 percent (59.9 megatonnes) of greenhouse gas (GHG) emissions.

This sector comprises many building types (see Figure 5-1). Retail and office space account for nearly half of commercial and institutional sector energy demand. Schools, health care facilities and hotels and restaurants account for another 35 percent of that demand. NRCan programs address all of these major energy-using building types.

Energy is used for six purposes in commercial and institutional buildings. The largest of these is space heating, which accounts for more than half of this sector's entire energy demand (see Figure 5-2). Each of the remaining five uses of energy in this sector accounts for between 4.0 and 14.0 percent of its energy demand.

Between 1990 and 2000, commercial and institutional energy use increased by 22.1 percent, or 192 petajoules (from 867 to 1059 petajoules). However, GHG emissions from the sector rose by 25.3 percent in the same period. The main factor causing emissions to increase more quickly than energy use was the increased use of energy sources with a higher GHG content.

FIGURE 5-1

Commercial and Institutional Energy Use by Building Type, 2000

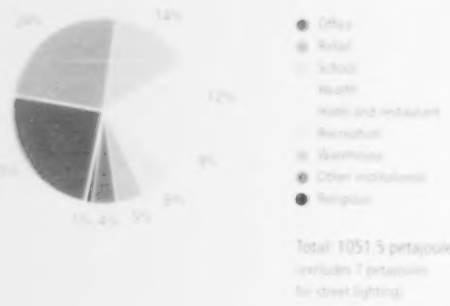


FIGURE 5-2

Commercial and Institutional Energy Use by Purpose, 2000

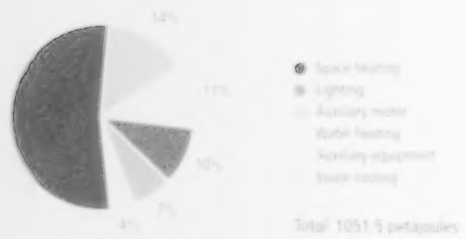


FIGURE 5-3

Commercial and Institutional Energy Use and Energy Savings Due to Energy Efficiency, 1990 to 2000

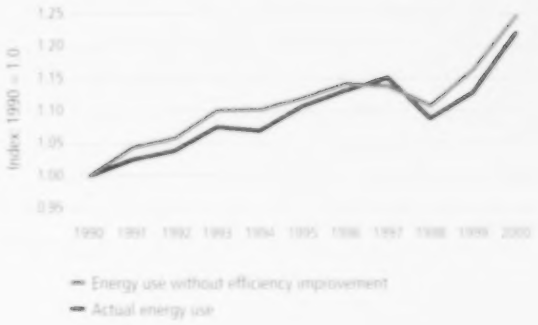
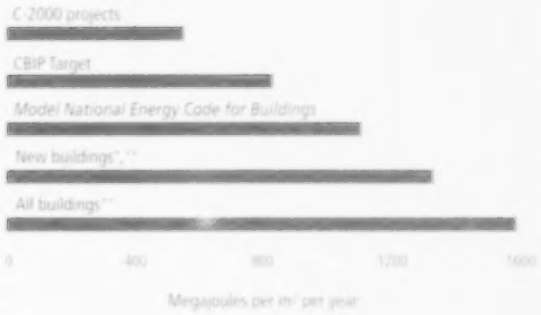


FIGURE 5-4

Energy Use in Commercial Buildings, 1999

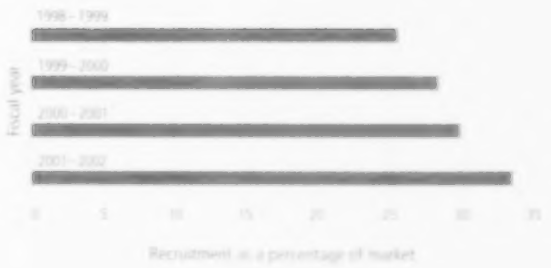


* 1990 – 1999

** Source: Commercial and Institutional Building Energy Use Survey, 2000. Estimates relate only to the surveyed area of populations over 175 000 and in Atlantic Canada populations of over 50 000.

FIGURE 5-5

Market Penetration of Energy Innovators Initiative in Commercial and Institutional Sectors



During the period 1990–2000, activity was the main factor tending to increase energy use; energy efficiency tended to decrease energy use. Structure (the mix of building types) and weather varied by only a minor extent. Specifically, the changes attributed to each of these factors are

- activity – an increase of 205 petajoules in energy use;
- weather – an increase of 8 petajoules;
- energy efficiency – a decrease of 22 petajoules; and
- structure – an increase of 3 petajoules.

If only activity, weather and structure had been in effect, commercial and institutional energy use would have increased by 25.0 percent (217 petajoules). However, improvements in energy efficiency worked to decrease energy use by 2.7 percent (23 petajoules). As a result, energy use increased by only 22.1 percent. This change in energy use during 1990 to 2000, as well as the energy savings due to energy efficiency, is shown in Figure 5-3.

NRCan delivers initiatives to increase energy efficiency in the following subsectors of the commercial and institutional sector:

- new buildings;
- existing buildings; and
- equipment.

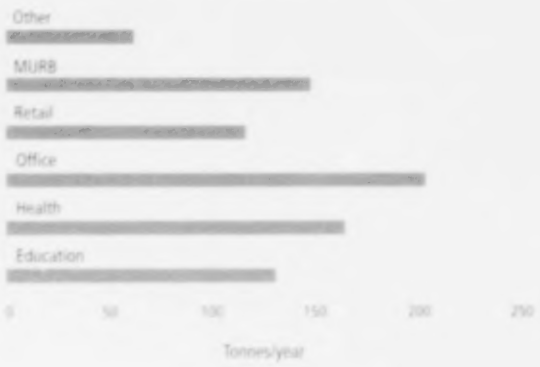
New Buildings: **Commercial Building Incentive Program (CBIP)**

Objective: To improve the energy efficiency of new commercial, institutional and multi-unit residential buildings.

CBIP provides financial incentives to builders and developers who incorporate energy-efficient features into the design and construction of new commercial, institutional and multi-unit residential buildings (MURBs). To qualify for the incentive, buildings must be at least 25 percent more efficient than similar buildings constructed to the *Model National Energy Code for Buildings* (MNECB).

FIGURE 5-6

Average GHG Reductions by Institution Under CBIP, 2002



Key 2001–2002 Achievements

- 63 new contributions worth over $4.2 million in total were issued to building owners.
- 700 engineers and architects were exposed to CBIP via the Royal Architectural Institute of Canada's continuing education.

For more information:
oee.nrcan.gc.ca/newbuildings/cbip.cfm

New Buildings: **Industrial Building Incentive Program (IBIP)**

Objective: To improve the energy efficiency of new industrial buildings.

IBIP extends the precepts of CBIP to the industrial sector. IBIP offers an incentive to companies building new energy-efficient industrial facilities, to offset additional design costs inherent in the initial attempts at energy-efficient designs and building/process integration. The design is assessed against a reference generated from the MNECB.

Key 2001–2002 Achievements

- Signed two contribution agreements.

For more information:
oee.nrcan.gc.ca/newbuildings/ibip.cfm

New Buildings: **Green Buildings**

Objective: To reduce energy and resource consumption and dangerous emissions from commercial buildings while increasing cost effectiveness through the use of high-performance buildings.

The program plays a significant role in establishing goals for energy efficiency and sustainability in commercial buildings through various activities, including C-2000, the Green Building Challenge (GBC) and integrated design process charrettes. NRCan launched the GBC process in 1996 to develop an international method of assessing the environmental performance of buildings and to test it on buildings in each country. GBC staff provide technical advice and support to NRCan's CBIP.

- For CBIP, staff analysed 1200 Expressions of Interest and more than 700 building submissions. Of these, 214 have shown energy-use improvements of at least 25 percent compared with the MNECB reference. On average, CBIP buildings were 32 percent better than the level required by the MNECB, at an average cost premium of 4.5 percent. Four of those buildings showed reductions of between 40 and 45 percent for no capital construction cost increase.
- GBC process assessments are conducted with GBTool™, developed by NRCan. At the first GBC conference, 14 countries participated; at the second in 2000, 19 countries. The third event, held in Oslo, Norway, in September 2002, showed the work of 16 participating national teams. Since 1996, 26 different countries have been involved.

Key 2001–2002 Achievements

- The first building in Manitoba completed under NRCan's C-2000 Program for Advanced Commercial Buildings opened. The Mountain Equipment Co-op store represents one of the most aggressive attempts in North America to reduce embodied energy in new construction, with 95 percent of the building constructed out of recycled and reused materials.
- Helped organize an energy-efficient design charrette for a large renovation project in Montréal, Quebec. This workshop, intended to develop design ideas for major projects, is expected to have a major influence on the Montreal design community.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

Existing Buildings: **Energy Innovators Initiative**

Objective: To encourage commercial businesses and public institutions to make investments in energy efficiency and reduce GHG emissions.

The Energy Innovators Initiative (EII) helps commercial organizations and public institutions explore energy efficiency options and strategies, offering them access to tools and financial assistance to help reduce energy costs and improve competitiveness. Members join EII by sending a letter to the Minister of Natural Resources Canada that makes a commitment to energy efficiency.

TABLE 5-1

Energy Innovators Initiative: Incentive Projects from 1998 to 2002

Federal incentive	$12.8 million
Client investment	$259.7 million
Annual energy savings ($)	$32 million
Annual energy savings (gigajoule)	2,398 million

Key 2001–2002 Achievements

- By the end of the fiscal year, over 700 organizations representing about 30 percent of the sector's floor space had been recruited as Energy Innovators.

For more information:
oee.nrcan.gc.ca/eii/home.cfm

Equipment: **Energy Efficiency Standards and Regulations**

Objective: To eliminate the less energy-efficient models of energy-using equipment from the market through minimum performance regulations under the *Energy Efficiency Act*.

The Regulations incorporate national consensus performance standards that include testing procedures to determine the energy performance of the equipment. They prohibit imports of, or interprovincial trade in, prescribed products that fail to meet minimum energy-performance levels and labelling requirements.

Key 2001–2002 Achievements

- The Regulations cover products that consume 80 percent of the energy used in the residential sector and 50 percent in the commercial and institutional sector.

For more information:
oee.nrcan.gc.ca/regulations/home_page.cfm

FIGURE 5-7

Estimated Energy Savings from Motor Regulations, 2000 to 2020

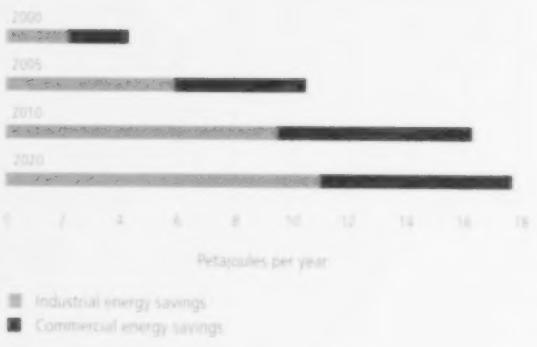


TABLE 5-2

Savings Arising from Canadian Energy Efficiency Lighting Regulations

Annual sales of lamps affected by regulations	$33 million
Estimated direct savings of electricity used for lighting in 2000	39 petajoules
Estimated net energy savings in 2000*	10 petajoules
Estimated net reduction in GHG emissions in 2000	5.5 megatonnes

*The estimate of net energy savings is lower than the estimate of direct savings of electricity and is partially offset by an increase in space-heating demand required because more efficient lighting emits less heat. When this effect is taken into account, estimated energy savings are less. The net effect varies by region and building.

Equipment: **Buildings Program**

Objective: To develop and transfer refrigeration and intelligent buildings technologies, in partnership with industry, and provide technical support for the deployment of ground-source heat pumps.

Key 2001–2002 Achievements

- With partners in Quebec, retrofitted an arena in Victoriaville and installed energy-saving equipment at a new arena in Val-des-Monts. These projects demonstrate energy-efficient technologies and practices.
- Completed prefeasibility study of advanced refrigeration, heating, cooling and dehumidification technologies for a "green supermarket" in Quebec.
- Began testing the Diagnostic Agent for Building Operators, a computerized tool that allows the detection and diagnosis of mechanical system defects in buildings.
- Initiated project to develop an intelligent building controller with fault detection and diagnosis for commercial buildings.

For more information:
cetc-varennes.nrcan.gc.ca/eng/batiments.html

Equipment: **Simulation**

Objective: To contribute to the improvement of performance, cost-effectiveness and integration and deployment of energy-efficient building technologies and techniques, including applications-driven implementation tools for market.

Through the Simulation Program, the Simulation Team develops, distributes and supports building simulation software for the Canadian building industry. Architects and engineers use these software tools to optimize the energy performance of building designs and to demonstrate compliance with programs and regulations such as R-2000, CBIP, the *Model National Energy Code for Buildings* and the *Model National Energy Code for Houses*. The team is involved in all aspects of the software development process, from design and programming to distribution, maintenance, user training and user support.

- Over 44 874 houses have been simulated for NRCan's R-2000 Initiative and EnerGuide for Houses program; 799 simulations have been performed to meet CBIP requirements.
- NRCan designed the world's first whole-building simulation model with solid oxide fuel cell cogeneration capabilities, incorporated it into a custom software package and delivered it to a Canadian fuel cell manufacturer to help it optimize its technology design.

Key 2001–2002 Achievements

- Hosted the first Canadian conference on building energy simulations (eSim), leading to the formation of a Canadian chapter of the International Building Performance Simulation Association and a commitment by the association to hold an annual eSim conference.
- Established residential-building energy simulation network with six universities (Concordia, Dalhousie, École Polytechnique de Montréal, Ryerson, Toronto, Waterloo). Through the network, new-building simulation research, algorithm development and simulation techniques are being developed, which will advance Canadian capacity for building simulation.

For more information:
buildingsgroup.nrcan.gc.ca/simulation/simulation_e.html

Equipment: **Bringing Energy-Efficient Technologies to Market**

Objective: To accelerate the development and adoption of energy-efficient building technologies into market.

The program works in partnership with associations, government and business to develop highly specialized solutions, thereby helping to reduce the energy consumption and GHG emissions of buildings in Canada in a cost-effective manner.

- Activities in energy-efficient ventilation for improved air quality have resulted in the commercialization of the residential heat recovery ventilator. Canadian companies now turn out up to 50 000 units a year. In cooperation with the Heating, Refrigeration and Air Conditioning Institute of Canada, NRCan has supported the development of national standards for residential mechanical ventilation, as well as training and education programs for equipment installation.
- In cooperation with the Canadian window industry, program staff developed CSA International standards, guidelines and tools to enable energy-efficient windows to be commercialized. Staff were involved in developing the Edgetech Super Spacer® for windows, which was made available to the market in the early 1990s.

Key 2001–2002 Achievements

- Unveiled the new eKOCOMFORT™ system, a product that integrates a space-heating system, water heating and ventilation. Six companies were selected to contribute to developing such advanced home-energy systems. The first of the products has now entered the market.
- The Canadian Centre for Housing Technology is an advanced testing facility for housing technologies managed in partnership between NRCan, National Research Council Canada and Canada Mortgage and Housing Corporation. Products tested this year include advanced integrated mechanical systems, a waste-water heat recovery system and electronically commutated motors.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

Chapter 6: Industry

Energy Use and Greenhouse Gas Emissions

The industrial sector includes forestry, construction and mining as well as all manufacturing. This sector uses energy in industrial processes as a source of motive power, to produce heat or to generate steam. Overall, industrial energy demand accounts for 39.2 percent (3069 petajoules) of secondary energy use and 33.6 percent (151 megatonnes) of greenhouse gas (GHG) emissions.

Within the industrial sector, energy is consumed primarily in the petroleum refining, iron and steel, upstream mining, aluminum, organic chemicals, pulp and newsprint and other paper industries. Together, these sectors accounted for 64.5 percent of total industrial energy demand in 2000 (see Figure 6-1).

In most industries, energy purchases account for only a small proportion of total expenditures. However, for some relatively energy-intensive industries – lime, cement, magnesium and aluminum – this share is higher than 15.0 percent (see Figure 6-2).

After decreasing slightly from 1990 to 1991 as a result of the recession, industrial energy use had increased by about 16.3 percent (449 petajoules) by 2000 (from 2755 to 3204 petajoules) (see Figure 6-3). The main factor that increases industrial energy use is activity.

- activity – increases in physical industrial output, gross output and gross domestic product contributed to an increase in energy use of 36.5 percent (1005 petajoules); and
- structure – the change in the mix of activity toward less energy-intensive industries (such as electric and electronic) resulted in an 11.5 percent decrease in energy use (317 petajoules).

FIGURE 6-1

Industrial Energy Use by Subsector, 2000

FIGURE 6-2

Cost of Energy to Industry as a Percentage of Total Production Cost, 1998

FIGURE 6-3

Industrial Energy Use and Energy Savings Due to Energy Efficiency, 1990 to 2000

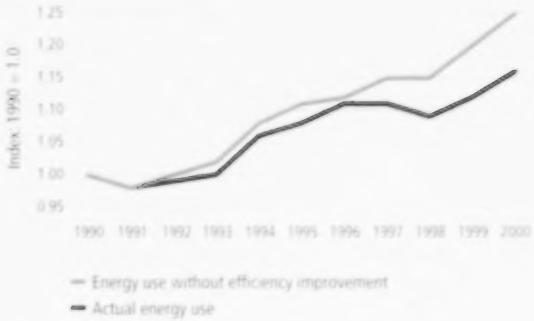


FIGURE 6-4

Reduction in Energy Use per Unit of Output for Selected Industries, 1990 to 2000

If only these two factors had been in effect, industrial energy use would have increased by 25.0 percent (688 petajoules). However, improvements in energy efficiency worked to decrease energy use by 8.7 percent (239 petajoules). As a result, energy use increased by only 16.3 percent. This change in energy use during 1990 to 2000 and the energy savings due to energy efficiency are shown in Figure 6-3.

Whereas energy use between 1990 and 2000 increased by 16.3 percent, industrial GHG emissions increased by only 12.9 percent.

Natural Resources Canada (NRCan) delivers initiatives to increase energy efficiency in the following subsectors of the industrial sector:

- industrial processes and technologies; and
- equipment.

Industrial Processes and Technologies: **Industrial Energy Efficiency**

(Canadian Industry Program for Energy Conservation [CIPEC] and Industrial Energy Innovators [IEI])

Objective: To help Canadian industry use energy efficiency investments to improve competitiveness and to contribute to Canada's climate change goals.

CIPEC, a sector-level program, and IEI, a company-level program, address barriers to planning, implementing and tracking energy efficiency projects in industry. Key elements include the establishment and tracking of energy efficiency improvement targets and plans, and the development of products that overcome barriers to continued energy efficiency improvement. NRCan provides support via employee awareness kits, best-practices guides, technical information and workshops on energy management.

Key 2001–2002 Achievements

- Signed Letters of Cooperation were received from the Canadian Association of Petroleum Producers, the Small Explorers and Producers Association of Canada, the Canadian Electricity Association, the Canadian Construction Association and the Fisheries Council of Canada.
- Launched energy management workshops in the upstream oil and gas sector.

For more information:
oee.nrcan.gc.ca/cipec/ieep

FIGURE 6-5

Industrial Energy Innovators and Action Plans, 1995–1996 to 2001–2002

FIGURE 6-6

Participation in CIPEC Program – Participation Level in Program Elements and Consequences to Energy Consumption

Mean 5-Year Increases in Energy Consumption

Industrial Processes and Technologies: Advanced Combustion Technologies

Objective: To help industry develop cleaner, more energy-efficient combustion processes, with lower emissions of acid rain precursors, GHGs, particulates and identified priority substances – trace elements and organic compounds.

Research focuses on optimizing the performance of stationary combustion equipment and developing and evaluating new products, fuels and retrofit technologies, using conventional fuels – oil, coal and natural gas – as well as biomass and specialty fuels.

Key 2001–2002 Achievements

- Completed a series of tests, burning mixtures of coal and tar-pond sludge in a mini-circulating fluidized bed combustion facility, demonstrating the technology to be an environmentally benign way of destroying PCB-laden tarry sludge from the tar ponds in Sydney, Nova Scotia.
- Successfully completed a six-year testing program for Syncrude Canada Ltd. that will enable Syncrude to significantly increase the yield from its cokers by optimizing operating parameters and nozzle design.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_act_e.html

Industrial Processes and Technologies: Processing and Environmental Catalysis Program

Objective: To solve industrial process problems and undertake research in areas with high potential for significant environmental and economic benefits.

The program's facilities, including semi-pilot scale plants, are used for process testing and the evaluation of novel concepts in chemical and energy conversion. Clients include oil and gas companies, petrochemical companies, original engine manufacturers, waste oil renderers and specialty ceramic manufacturers.

Key 2001–2002 Achievements

- Obtained two patents on novel materials for proton-conducting ceramic membrane materials for hydrogen separation and made significant improvement to ceramic membranes for hydrogen separation.
- Proved the concept of a new generation of fuel cell reactor technology, offering significant improvement in energy efficiency for the chemical processing of natural gas to synthesis gas or hydrogen.
- Developed technology for the production of low-sulphur, high-cetane blending stock from waste restaurant grease and vegetable oils. Engine testing of fuels blended with this oil is underway.
- Filed patent on a low-temperature technology for removing sulphur from waste oil products. This improved energy-efficient process is now being tested.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_pec_e.html

Industrial Processes and Technologies: Industrial Process Engineering Program

Objective: To enable industry to continuously improve its energy efficiency and productivity, while decreasing GHG and other pollutant emissions.

The program focuses on industrial drying and the catalytic flow reversal reactor technology. It seeks to meet its objective by performing leveraged research and development (R&D), introducing novel technologies, performing incremental improvements, performing industrial audits and disseminating technical information.

Key 2001–2002 Achievements

- Signed licence agreement with a multinational dryer company to market the NRCan-developed and patented, energy-efficient, pulse fluid bed dryer in Canada and around the world.
- Initiated five-year project to reduce energy consumption in the solid wood manufacturing sector. The project will reduce the energy consumption of wood kilns by an average of 15 percent, which could translate into a reduction of 500 kilotonnes of carbon dioxide (CO_2) emissions per year.
- In collaboration with partners, began joint project to develop a new control method to improve efficiency in wood drying sawmill operations.
- Signed contract with Manitoba Hydro to adapt jet-spouted bed drying technology for processing food and agri-food products. This energy-efficient technology improves the quality of the dried products in food processing plants.

For more information:
cetc-varennes.nrcan.gc.ca/eng/industrie.html

Industrial Processes and Technologies: Industrial Process Integration Program

Objective: To support the development and adoption of process integration in various industries.

The program focuses on combined heat-and-power optimization methodologies, total site optimization methodologies, batch-processes optimization methodologies, and water-pinch optimization methodologies in the agri-food, pulp and paper and textile industries. It also focuses on building an international-calibre Canadian capacity in process integration.

Key 2001–2002 Achievements

- Two-day course on optimization of industrial cogeneration and site utility systems management for industry, utility providers and government representatives.
- With Anjou Recherche (Vivendi Water Inc.), produced a study of a metallurgical plant to optimize its cooling system. The study used state-of-the-art distributed cooling methodologies and optimization techniques developed by NRCan.
- Began a process integration study at the Norampac Inc. paperboard mill in Red Rock, Ontario, to identify and evaluate energy savings and water management opportunities.
- With Quebec's Agence de l'efficacité énergétique, completed analysis and review of energy-efficient best practices in the meat and dairy processing sectors and the beer and beverage industries.

For more information:
cetc-varennes.nrcan.gc.ca/eng/programmes_industrie.html

Industrial Processes and Technologies:
Industry Energy Research and Development (IERD) Program

Objective: To encourage and support the development and application of leading-edge, energy-efficient and environmentally responsible processes, products, systems and equipment in industry.

Financial support is provided for commercially confidential applied R&D activities, which is repayable if the project is commercially successful. Program clients from all industrial sectors range from small- and medium-sized companies to multinational corporations.

- Since its inception (1977), IERD has helped a variety of Canadian companies, supporting 125 R&D projects and contributing $93 million toward $388 million-worth of projects for the development of advanced energy-efficient technologies. This effort also contributes inherently to sustainable development and GHG emissions reduction.

Key 2001–2002 Achievements

- Diversified Metals Engineering of Prince Edward Island is developing systems to recover and use waste heat from marine diesel engines. The system reduces fuel consumption and removes sulphur dioxide and particulate matter.
- Turbocor Inc. of Quebec is developing a new non-chlorofluorocarbon compressor for refrigeration application. This equipment represents a breakthrough in industrial and commercial refrigeration and is expected to yield energy savings of 30 percent.
- Ontario's Fielding Chemical Technologies Inc. is developing a process to recycle industrial solvent and waste streams. Sizeable energy savings and related GHG emissions reductions could be achieved by reusing these solvents.
- Agile Systems Inc. of Ontario is developing an electronics control technology that will accelerate the market uptake for fuel cells in residential and automotive applications by offering increased flexibility and reduced space, weight and cost.

For more information:
nrcan.gc.ca/es/eb/cetc/cetc01/htmldocs/programs_ierd_e.html

Industrial Processes and Technologies:
Emerging Technologies Program (ETP)

Objective: To support the identification and demonstration of new and emerging energy-efficient technologies.

Projects are co-managed and cost-shared with industry and other stakeholders, such as gas and electric utilities, other governments and equipment manufacturers. Most activities have taken place within the industrial sector. Financial support is provided for the development and testing of pilot plants, prototypes and full-scale field trials to evaluate operating performance, energy efficiency and environmental impacts. NRCan's financial support is repayable from any cost savings or revenues realized from a project.

- Since 1991, ETP and its forerunner, the Industrial Targeted Program (ITP), have contributed $19 million to 105 projects worth $143 million.

Key 2001–2002 Achievements

- ZENON Environmental Inc. demonstrated its water filtration technology in a range of applications. The technology uses 80 percent less energy than conventional methods.

- Participated with a number of leading Canadian coal users in study, development and demonstration of clean coal technology for power generation.
- Westport Research Inc. undertook a one-year field trial of a low-emissions natural gas engine for stationary power generation.
- Hydrogenics Corporation is developing an automated test station for residential fuel cells and their sub-systems.
- Levelton Engineering Ltd. tested high-volume fly ash in roller compacted concrete in an industrial paving application. By replacing cement with fly ash, the energy content and CO_2 emissions from concrete production are reduced significantly.

Industrial Processes and Technologies: Energy Technologies for High-Temperature Processes (EHTP)

Objective: To investigate technologies and develop knowledge to ensure the sustainability of Canada's coal, carbon and metallurgical industries.

EHTP has expertise in carbonization, combustion, agglomeration, thermal rheology petrography and environmental and carbon science technologies to address energy efficiency, GHG reduction and related needs of industry. Key areas include alternative iron-making technology, fuel products, iron and steel process efficiency, standardization and analysis of emissions.

Key 2001–2002 Achievements

- Completed coke stabilization study for two Canadian steel plants, demonstrating significant opportunities to improve coke quality, reduce coke consumption and achieve significant energy savings. As a result, one Canadian steel company has set targets for improved coke quality to achieve voluntary GHG reduction limits.
- Published reports on coke modelling, showing that Canadian coal can be substituted for Australian coal in Steel Authority of India blends. This could open India's $300-million coking coal market to Canadian coals.
- Coal and natural gas co-injection studies for Stelco Inc. and Union Gas Limited highlighting improved energy efficiencies in iron-making.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_ehtp_e.html

Industrial Processes and Technologies: **International Centre for Sustainable Development of Cement and Concrete (ICON)**

Objective: To support the growth of concrete as a valuable building material, a sustainable development approach is needed toward the production of cement and concrete, an approach that balances environmental concerns with social and economic considerations.

ICON continues to work with the cement and concrete industry to develop and evaluate high-performance concretes, to increase their durability and mitigate the effects of alkali aggregate reaction and to promote the use of supplementary cementing materials, particularly high-volume fly ash concrete, in order to help reduce global demands for Portland cement.

Key 2001–2002 Achievements

- Sponsored, organized and conducted 7th CANMET/ACI International Conference on Fly Ash, Silica Fume, Slag and Natural Pozzolans in Concrete, Madras, India, July 2001.
- Sponsored, organized and conducted 5th CANMET/ACI International Conference on Recent Advances in Concrete Technology, Singapore, August 2001.
- Successful completion of a design mission for a development project in India sponsored by the Canadian International Development Agency. It included identification of key Indian stakeholders and partners, evaluation of Indian fly ash for use in the High-Volume Fly Ash Concrete System developed at CANMET and a successful field trial in the state of Maharashtra.
- Contributed to the development of a new air-entraining admixture for use in concrete, incorporating fly ash with high-carbon content. Project in collaboration with the industry and Universite de Sherbrooke.

Equipment: Energy Efficiency Standards and Regulations

Objective: To eliminate the less energy-efficient models of energy-using equipment from the market through minimum performance regulations under the *Energy Efficiency Act*.

The Regulations incorporate national consensus performance standards that include testing procedures to determine the energy performance of the equipment. They prohibit imports of, or interprovincial trade in, prescribed products that fail to meet minimum energy performance levels and labelling requirements.

Key 2001–2002 Achievements

- The Regulations cover products that consume 80 percent of the energy used in the residential sector and 50 percent in the commercial and institutional sector.

For more information:
oee.nrcan.gc.ca/regulations

Equipment: **EnerGuide for Industry**

Objective: To promote and encourage the manufacture, purchase and use of more energy-efficient industrial equipment.

EnerGuide for Industry is a labelling/rating program for industry that follows principles similar to those for the EnerGuide for Equipment program. EnerGuide for Industry targets commonly used "off the shelf" industrial equipment, such as motors, pumps, transformers, compressors, boilers and lights. The program aims to ultimately reduce energy-use-related GHGs by improving the efficiency of the stock of energy-using equipment available for industrial applications.

Key 2001–2002 Achievements

- High-Intensity Discharge Ballast study completed.

Equipment: Mine Ventilation

Objective: To reduce energy consumption associated with mine ventilation by using the concept of "ventilation on demand," ventilation infrastructure automation and ventilation network optimization and management.

Electrical energy associated with mine ventilation represents about 40 percent of the electrical energy required for underground mine production. Furthermore, there is a cubic relation between a given airflow reduction and the power economy that ensues, making ventilation management a worthwhile endeavour, both economically and environmentally.

Key 2001–2002 Achievements

- Feasibility study of using "ventilation on demand" within INCO Limited's Creighton Mine's deep ore zone to minimize ventilation costs.
- NRCan scientist has begun Ph.D. studies at the University of British Columbia in collaboration with INCO Limited. The thesis deals with linking mine-ventilation delivery and modelling with computerized mine-development models to reduce ventilation costs.

Equipment: **Water-Powered Hydraulic Drill (CANDRILL)**

Objective: To reduce hazards faced by miners, while increasing energy efficiency.

The CANDRILL, a rockdrill powered by a high-pressure water system rather than compressed air, and the system that runs it, will dramatically reduce several of the hazards faced by miners while at the same time increasing efficiency. At present, compressed air is the main power source for narrow-vein mining equipment. Rockdrills powered by compressed air create high levels of noise, dust and vibration while generating an oil mist that is a potential health hazard. These factors cost the mining industry many thousands of dollars every year in Canada alone. The CANDRILL will increase energy efficiency (from 30 to 50 percent) while dramatically reducing several of the hazards faced by miners.

Key 2001–2002 Achievements

- Testing indicates that, compared with its compressed-air counterpart, the new rockdrill drills holes twice as quickly, offers reduced vibration, dust and noise (15 decibels quieter), weighs less (14 kilograms lighter) and eliminates oil mist emissions.

Chapter 7: Transportation

Energy Use and Greenhouse Gas Emissions

The transportation sector consists of three subsectors: passenger, freight and off-road. Passenger and freight transportation accounted for 56.7 percent and 39.7 percent, respectively, of transportation energy use, with off-road representing only 3.6 percent in 2000. The passenger subsector is composed of three modes: road, rail and air. The freight subsector comprises road, rail and marine. Road transport uses the most energy, accounting for 77.3 percent of total transportation energy use in 2000. Of this amount, 59.7 percent was passenger energy use and 40.3 percent was freight energy use (see Figure 7-1). All NRCan transportation energy-use programs focus on the energy used in road transportation.

FIGURE 7-1

Transportation Energy Use by Mode, 2000

Transportation energy use increased by more than 21.5 percent (404 petajoules) during the years 1990 to 2000 (see Figure 7-2). Passenger transportation energy use increased by almost 12.6 percent (145 petajoules), while freight transportation energy use increased by 34.1 percent (230 petajoules). Two main factors were responsible for this increase – activity and structure:

- activity – due to increases in population and economic activity, there was greater transportation activity (measured as passenger-kilometres for passenger transportation and tonne-kilometres for freight transportation). This increased transportation energy use by almost 23 percent (410 petajoules). The freight and passenger segments contributed to this increase by 60.4 percent and 39.6 percent, respectively; and
- structure – shifts between modes of transport were significant in the freight segment, resulting in an increase of more than 8.9 percent in transportation energy use (177 petajoules).

FIGURE 7-2

Transportation Energy Use and Energy Savings Due to Energy Efficiency, 1990 to 2000

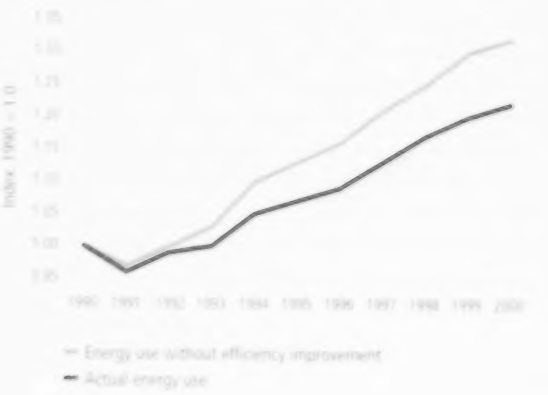
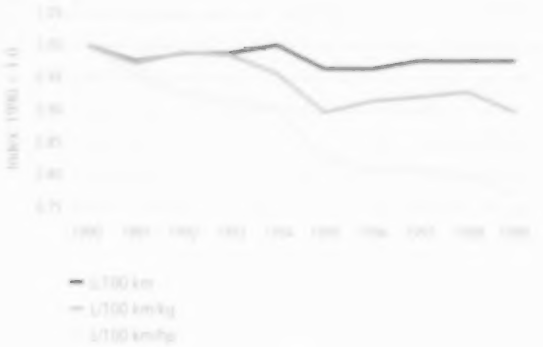


FIGURE 7-3

Market Shares of New Light Trucks and Passenger Cars, 1990 to 2000

FIGURE 7-4

New Car Fuel Efficiency, Normalized for Weight and Power, 1990 to 1999



If only these two factors had been in effect, transportation energy use would have increased by almost 39.9 percent (588 petajoules). However, improvements in energy efficiency worked to decrease energy use by 11.3 percent (202 petajoules). As a result, energy use increased by only 21.5 percent. This change in energy use during 1990 to 2000, as well as the energy savings due to energy efficiency, is shown in Figure 7-2.

The transportation sector accounts for more than 28 percent (2282 petajoules) of secondary energy use and more than 34.5 percent (163 megatonnes) of greenhouse gas (GHG) emissions. From 1990 to 2000, transportation energy use increased by more than 21.5 percent, and GHG emissions increased by 21.0 percent. The change in GHG intensity of transportation energy use was negligible.

NRCan delivers initiatives in the following areas to increase the efficiency of motor vehicles and encourage the use of alternative fuels:

- personal vehicles;
- commercial fleets;
- transportation research and development; and
- alternative transportation fuels.

Personal Vehicles: Vehicle Efficiency Targets

Objective: To improve the fuel efficiency of new motor vehicles.

This initiative with vehicle manufacturers aims to improve motor vehicle fuel efficiency. The initiative encourages manufacturers to voluntarily meet standards for company average fuel consumption for new automobiles and light trucks sold in Canada. In addition, Natural Resources Canada (NRCan) and vehicle manufacturers seek to improve both new vehicle and on-road vehicle fuel efficiency through advancements in vehicle technology and changes in the behaviour of vehicle owners and operators.

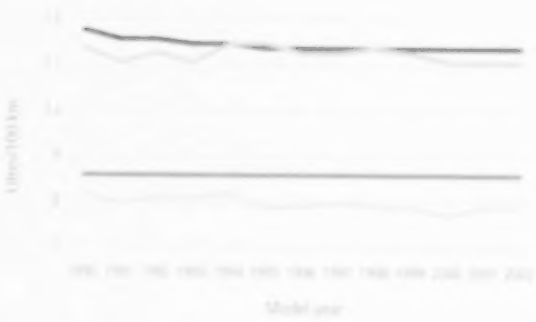
Key 2001–2002 Achievements

- Policy coordination and joint studies under the NRCan/U.S. Department of Energy Memorandum of Understanding to support the development of a new fuel efficiency target.
- Reports: *Analysis of Alternative Fuel Economy Program Designs; Assessment of costs and fuel economy potential of 42-volt hybrid drive technologies.*
- Consultations with stakeholders and partners on implementing the consumer education campaign.
- Market research in partnership with the Canadian Petroleum Products Institute, the Agence de l'efficacité énergétique du Québec and Transport Canada.
- Thirty advanced technology vehicles acquired, 352 evaluations completed.

For more information:
oee.nrcan.gc.ca/english/programs/motorvehicles.cfm

FIGURE 7-5

Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards



Personal Vehicles: **Personal Vehicle Program**

Objective: To improve motor vehicle fuel efficiency by encouraging private motorists to develop energy-efficient vehicle purchase, use and maintenance practices.

FIGURE 7-6

Vehicle Fuel Efficiency Awareness

Awareness of the program (general public)
Recollection of information on how to reduce vehicle fuel consumption (general public)
Percentage of new vehicles in showroom with EnerGuide Label
Percentage of new vehicles in lot with EnerGuide Label
Percentage
1998
1999
2001
2002

Under a voluntary agreement, vehicle manufacturers attach an EnerGuide fuel consumption label to new cars, vans and light-duty trucks to be sold in Canada. This and the annual *Fuel Consumption Guide* provide consumers with fuel consumption ratings and the estimated annual fuel cost of the vehicle. Additionally, the annual EnerGuide for Vehicles Awards highlight the year's most fuel-efficient vehicles in each size class.

The program encourages motorists to buy, drive and maintain their vehicles in energy-efficient ways that save fuel and money, and reduce vehicle emissions through various kits, guides, information dissemination activities and strategic alliances with public and private sector organizations. In addition to a guide, Web site and education and awareness campaigns, resource materials on vehicle fuel efficiency are provided to driver educators for their novice-driver training curricula.

Key 2001–2002 Achievements

- Recruited Volvo Cars of Canada Ltd. to the EnerGuide for Vehicles program and retained all other companies.
- Achieved 77 percent compliance for EnerGuide for Vehicles on dealership lots, 56 percent in showrooms.
- Distributed over 285 000 copies of the 2002 *Fuel Consumption Guide* through vehicle dealerships, distributed 700 000 publications and logged over 145 000 user sessions on the Web site.
- Reached over 170 000 novice drivers directly; exhibited the student driving materials at three workshops (each averaging 600 participants) and at one annual conference (50 participants).

For more information:
oee.nrcan.gc.ca/vehicles

Commercial Fleets: **Fleet Vehicle Program**

Objective: To improve fuel efficiency and the use of alternative fuels in commercial and municipal fleets.

Information materials, workshops, technical demonstrations and training programs help fleet operators assess and develop opportunities to increase energy efficiency in their operations. NRCan delivers the program in partnership with fleet and industry associations and other levels of government.

Key 2001–2002 Achievements

- Total of 2707 registered members, representing 386 731 vehicles. Fiscal year saw 2180 new trainers and about 125 000 drivers, experienced and entry-level, in heavy truck and forest sectors, given SmartDriver materials. Launch of SmartDriver for Forestry Trucks program.
- Piloted "Fuel Management 101" workshop; provides fleet owners and managers with tools to develop and implement an energy management plan.
- Agreement with Canadian Association of Motive Power Educators (CAMPE) to deliver the "Fuel Management 101" workshop and develop a data-collection strategy to help fleets determine their fuel efficiency and GHG emissions baseline. This initiative will provide engine technician students with on-the-job supervised work experience and give the program an excellent source of fuel consumption and vehicle use data.
- Agreement with the Canadian Electricity Association to investigate the feasibility and viability of truck-stop electrification in the Canadian context.

For more information:
oee.nrcan.gc.ca/fleetsmart

Transportation Research and Development: **Canadian Lightweight Materials Research Initiative (CLiMRI)**

Objective: To develop and implement low-density and/or high-strength materials (referred to simply as lightweight materials) in transportation applications for the purposes of reducing GHG emissions through improved vehicle efficiency and improving the competitive performance of the Canadian primary metals, automotive, truck, bus and rail-car manufacturing industries and their associated parts suppliers.

CLiMRI has targeted lightweight, high-strength materials and efficient design of components in vehicles through improved engineering performance of materials, improved manufacturing technologies and improved component and vehicle systems. Significant progress was made using all three strategies this year. NRCan continues to coordinate the activities for CliMRI.

Key 2001–2002 Achievements

- NRCan's Materials Technology Laboratory led USAMP's (U.S. Department of Energy) project on "Investigation of Corrosion Factor and Protection Methods" which forms part of its major "Structural Cast Magnesium Development Project."
- Several coatings for lightweight aluminum heat exchangers, including epoxy-based and experimental Sol-gel systems, were tested in simulated condensing and immersion heat exchanger environments. Initial results were favourable, and testing of heat exchanger prototypes will take place during 2002–2003.

Transportation Research and Development: **Fuel-Cell-Powered Mining Vehicles**

Objective: To develop the technology to replace diesel power by hydrogen fuel cell power in underground mining vehicles.

NRCan has taken a leadership role in this North American consortium. If this initiative is successful, Canada stands poised to capture world markets for applied fuel cell technology in mining – a clear example of the link between innovation and economic growth.

The application of fuel cell technology to underground mining by retrofitting diesel-powered vehicles would provide a number of benefits, such as eliminating underground diesel emissions and reducing heat and noise, improving the work environment for underground miners, reducing a significant portion of carbon dioxide emissions (1 million tonnes per year), giving the mining industry an opportunity to contribute to Kyoto Protocol emissions targets and decreasing operating costs by lowering mine ventilation needs by more than 35 percent (ventilation is responsible for 40 percent of the electrical consumption in an underground mine) and by significantly improving vehicle productivity (hydrogen-fuel-cell power systems are twice as efficient in delivering power as conventional diesel equipment).

Key 2001–2002 Achievements

- The prototype locomotive propelled with hydrogen fuel cells, the only example of its kind, has been undergoing surface testing by NRCan since the beginning of 2002, most recently at its experimental mine in Val-d'Or, Quebec. NRCan also provided the expertise of scientists and engineers who integrated the fuel cell with the locomotive and its control systems and conducted surface testing. The locomotive will be moved soon to the Placer Dome Inc. mine in Red Lake, in northwestern Ontario, for underground testing and evaluation. It is expected that many different types of vehicles, including underground diesel loaders – the mainstay of metal mine production – will eventually use this technology, and pilot projects are now underway in Canada, the United States and other countries.

Alternative Transportation Fuels: **Vehicle Fuels**

Objective: To increase Canada's fuel ethanol production and use and to support the use and development of fuel cell and natural gas vehicles.

Three elements within the program seek to meet its objective. (1) The Future Fuels Initiative increases the supply and use of ethanol by increasing Canada's ethanol production capacity. A contingent loan-guarantee program reduces the financial risk of new plant construction. Other activities include public education, economic and market analyses, research of standards and harmonization of policies where possible. (2) The Canadian Transportation Fuel Cell Alliance (CTFCA) is a private-public sector partnership program made up of technology developers, fuel providers, auto manufacturers, federal and provincial government officials, academia and non-governmental organization (NGO) representatives. The Alliance advances the adoption of fuel cell vehicles through the development of a supporting framework, including common technical standards, codes, training, certification and safety. (3) The Natural Gas for Vehicles Program, for regions of Canada served by Alberta natural gas, provides financial contributions for each factory-built natural gas vehicle, for dealers to sell new factory-built natural gas vehicles and for existing road vehicles converted to use natural gas, as well as a contribution to help foster new refuelling outlets, marketing and awareness activities and co-funded R&D.

Key 2001–2002 Achievements

- Estimated amount of fuel ethanol blended into motor gasoline per year reached 240 million litres in 2001.
- Royal Dutch/Shell Group of Companies, refinery sector, invested $46 million in Iogen Corporation's cellulose-based ethanol technology.
- Saskatchewan and Manitoba announced intent to pursue and/or consult on regulatory instruments for ethanol in gasoline; several provinces expressed interest in federal-provincial-territorial collaborative efforts to expand the ethanol industry.
- Memorandum of Understanding signed between the California Air Resources Board (CARB) and NRCan to facilitate information sharing on fuel cell and hydrogen research, development and demonstration,
- Formative meeting of the CTFCA held September 2001: 100 representatives of hydrogen and fuel cell industry, federal and provincial governments, fuel and equipment suppliers, NGOs, vehicle manufacturers, transit operators and colleges and universities.
- In 2001 model year, 290 natural gas vehicles sold in Canada, of which 48 were purchased by the Government of Canada; over 250 conversions of on-road vehicles.
- In fall 2001, 145 fuelling facilities available to the public.

For more information:
alt-fuels.nrcan.gc.ca

Alternative Transportation Fuels:
Transportation Energy Technologies Program

Objective: In partnership with industry, to develop and deploy leading-edge transportation technologies that minimize environmental impacts, increase the potential for job and economic growth and extend the life span of Canada's energy resource base.

Program staff work with stakeholders in the domestic and international transportation industries, including original equipment manufacturers, industry associations, fleet managers, transit authorities, utilities, provincial and territorial governments, research organizations, universities, other federal departments, the U.S. Department of Energy and the International Energy Agency.

- Over the last 15 years, work in partnership with Canada's fuel cell industry has established Canada as a world leader in fuel cell and refuelling technologies; for example, the world's first hydrogen fuel cell bus was demonstrated in Canada.
- Since the 1980s the program has supported student vehicle challenges, bringing university and college students from across North America together with automotive manufacturers to modify existing vehicles to run a variety of alternative fuels.
- The program has supported the development of alternative transportation fuel technologies, for example, for natural gas vehicles, which has led to a Canadian industry that is now exporting commercial products to foreign markets.

Key 2001–2002 Achievements

- Organized and sponsored world-class conferences, including the 11th Canadian Hydrogen Association Conference in 2001, the Canadian Hydrogen Storage Workshop and the 2001 Windsor Workshop.
- Launched the Canadian Transportation Fuel Cell Alliance, a $23-million program funded by the *Government of Canada Action Plan 2000 on Climate Change* for developing the fuelling infrastructure for fuel cell vehicles.
- Signed MOU with the CARB to exchange information on fuel cell technologies.
- Signed agreement with Stuart Energy Systems Corporation to develop a low-cost water electrolysis system for intermediate and large-scale energy applications.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_tet_e.html

Chapter 8: Renewable Energy

Introduction

Renewable energy sources are those that produce electricity or thermal energy without depleting resources. Renewable energy includes solar, wind, water, earth and bioenergy, including energy from waste.

Natural Resources Canada (NRCan) delivers several initiatives to encourage the development and use of emerging renewable energy sources and technologies. However, these initiatives do not apply to the following renewable energy resources:

- large-scale hydro-electricity, a well-established renewable energy source; and
- ethanol fuel production from agricultural feedstocks, which is covered under Agriculture and Agri-Food Canada programs.

Each renewable energy source depends on one or more energy production technologies, with their own level of economic attractiveness. Some technologies are mature and well recognized (e.g., hydro-electricity), others are emerging in the marketplace, and many are in the laboratory stage but offer promise for the long term. Renewable energy sources compete in many markets, including those for electricity, mechanical power, thermal energy (process heat, space heating and cooling and water heating and cooling) and transportation fuels (see Table 8-1).

Renewable Energy Use

In 1999, renewable energy generation capacity from renewable sources accounted for 62 percent of total Canadian electricity capacity (see Table 8-2). Most of the renewable energy used in Canada comes from either hydro electricity or thermal energy from biomass such as wood-waste sources.

TABLE 8-1

Renewable Energy Markets and Technologies Used in Canada

Electricity	*Thermal Energy*
Hydro-electricity	Biomass (e.g., roundwood, pellets, wood chips)
Tidal power	Ground source heat pumps (e.g., earth energy)
Biomass (e.g., wood waste)	Solar air heating systems
Biogas (e.g., methane from landfill sites)	Solar hot water systems
Wind turbines	
Photovoltaic systems	
Mechanical Power	*Transportation*
Wind water pumps	Ethanol from biomass

TABLE 8-2

Electricity Generation Capacity from Renewable Sources (includes hydro)

	Total renewable energy, petajoules	*% of total capacity*
1990	58 578	58
1991	61 181	58
1992	62 983	58
1993	61 202	56
1994	63 247	56
1995	66 742	57
1996	67 323	58
1997	58 406	61
1998	68 545	62
1999	68 849	62

Source: Stats Can 57-202

Hydro-Electricity

Hydraulic power is a renewable energy based on the water cycle – evaporation, precipitation and flow of water toward the ocean. Canada has abundant water resources, and its geography provides many opportunities to produce low-cost energy. Tapping the energy from moving water has played an important role in the economic and social development of Canada for the past three centuries.

In 2001, hydro power accounted for approximately 58 percent of total electricity generation. Small-scale hydro-electric projects, with a capacity of 20 megawatts or less, constitute about 4 percent of Canada's electricity-generating capacity. Small-scale hydro has good potential for increased production.

Biomass

Bioenergy is a renewable source of energy derived from organic substances known as biomass. Biomass is supplied by agricultural wastes such as chaff, straw, grain screenings, husks and shells, food-processing residues and methane. Other biomass supplies include animal litter and manure, landfill gas methane, urban wastes to be incinerated and sewage for biogas. Bioenergy contributes about 6 percent of Canada's primary energy, mostly for industrial process heat, electricity generation and residential space heating. Corn and other agricultural products are also used to generate ethanol and biodiesels for the transportation market.

Bioenergy production represents Canada's second largest renewable energy source. Most bioenergy is produced from organic refuse and used with the facilities in which the energy conversion takes place. The pulp and paper industry produces and uses most of Canada's bioenergy. Industrially produced heat and electricity, independent power producers' electricity, electricity from urban wastes and residential wood heat are all considered commonplace in Canada's energy mix.

Home heating with wood usually takes the form of stand-alone wood stoves, water or forced-air wood furnaces, fireplaces with advanced combustion inserts, high-efficiency fireplaces or high-thermal-mass masonry heaters. About 3 million Canadian households use wood for home heating. Canadians usually prefer roundwood, but alternatives include wood chips and pellets.

Earth Energy

As a result of the sun heating the surface of the planet, the temperature of the earth that is one or two metres below the surface remains fairly constant – between 5°C and 10°C. This is warmer than outside air during the winter and cooler than outside air during the middle of summer. A ground-source heat pump takes advantage of this temperature difference by using the earth or the ground water as a source of heat in the winter and as a "sink" for heat removed from indoor air in the summer. For this reason, ground-source heat pumps are known as earth energy systems (EESs).

During winter, EES installations remove heat from the earth using a liquid, typically an antifreeze solution, that circulates within an underground loop. It then upgrades the heat with a conventional heat pump and transfers it to indoor space or the water heating system. During summer, the system reverses this process to operate as an air conditioner. EES installations supply less than 1 percent of the market for space and water heating and cooling in Canada.

Wind Energy

Wind turbines convert the kinetic energy of wind into electrical or mechanical energy. Canada has a very large wind resource potential because of its large size and northern location. A 1992 NRCan study estimated the technical wind energy potential in Canada at about 28 000 megawatts. If developed, this could supply 11 percent of total Canadian electricity consumption. In 2001, wind energy accounted for less than 1 percent of Canada's total electricity generation.

Wind energy also provides mechanical power. Several thousand wind-powered water pumps are used throughout Canada, mostly in the Prairie Provinces. As well, Canadians use small, residential-sized wind turbines to power cottages and remote houses (see Figure 8-1).

FIGURE 8-1

Canadian Wind Power Capacity, 1990 to 2000

Solar Energy

Three main technologies use energy from the sun:

- passive solar technologies mean that buildings are designed and located to maximize their reception of solar energy;
- active solar thermal systems convert solar radiation into thermal energy for heating air or water in residential, commercial and industrial applications; and
- solar electric (photovoltaic) systems use solar radiation to produce electricity.

During the 1990s, NRCan assisted a Canadian company in developing a perforated solar absorber to preheat ventilation air and reduce a building's fuel requirements for space heating. This technology is much more cost effective than conventional solar air heating technologies and is gaining acceptance in Canada and abroad. Systems have been installed on industrial, institutional and commercial buildings throughout Canada.

The installed photovoltaic (solar electric) capacity in 2001 was 8.1 megawatts, with an estimated annual production of 7.25 gigawatt hours of electricity. The bulk of this capacity is either "off grid" (not connected to an electrical transmission system), where the price of photovoltaics is competitive with conventional stand-alone power systems, or an extension of a grid to a given location. Typical applications include telecommunications systems, water pumping and purification, remote monitoring and control, remote residences, coast-guard lighting and beacon systems, and numerous consumer applications such as hand-held calculators. The Canadian Coast Guard is the largest individual user of photovoltaic systems in Canada, with an estimated 7000 navigational buoys, beacons and lighthouses. Canada has about 100 grid-connected photovoltaic systems, and they have a combined capacity of 315 kilowatts.

NRCan delivers several initiatives to increase the use of small-scale renewable energy in Canada. The following is the array of NRCan renewable energy programs, as well as an initiative in energy efficiency and renewable energy in Canadian communities.

Renewable Energy Programs: ENergy from the FORest (ENFOR)

Objective: To improve the understanding of the role of biomass production for energy and to improve biomass productivity in conventional forest stands and plantations.

ENFOR undertakes research and development on forest biomass for energy through the private sector, universities or Canadian Forest Service (CFS) research centres. Two primary sources of forest biomass for energy are under study: forest residues, including harvest residues, and energy plantations, involving short-rotation intensive culture in quick-growing trees, such as willow and poplar. ENFOR also supports research on information systems to determine the quantity and quality of biomass in Canadian forests. In effect since 1978, the ENFOR program has made a difference in forest science, knowledge and understanding of forest biomass production and the technology to increase the use of forest bioenergy. It does this by encouraging a different look at the world and by removing the barriers to increase the use of biomass.

- ENFOR successes include the *Forest Biomass Inventory of Canada*; the FORest nutrient Cycling and Yield Trend Evaluator (FORCYTE) model; the understanding of whole-tree harvesting and nutrient cycling; the CFS Carbon Budget Model; the development and testing of species, clones and production technologies for energy plantations; and technology transfer.

Key 2001–2002 Achievements

- Collaboration in international projects on forest biomass – workshops, seminars and publications have been the primary products.
- Evaluation of biomass plantations – Evaluation of the productivity of a willow biomass plantation farm, including growth, productivity, insect and disease damage, nutrients and public acceptance provided the information to assess the sustainability of such operations.
- Workshop on Agricultural and Forestry Biomass Supply for Energy – Attendees from CFS, NRCan, Agriculture and Agri-Food Canada, Environment Canada, universities and industry reviewed the state of the science of biomass supply and determined the gaps and defined strategic directions needed in bioenergy research.

For more information:
nrcan.gc.ca/cfs-scf/science/fundprog/enfor_e.html

Renewable Energy Programs: **Green Power Initiative**

Objective: To reduce greenhouse gas and other air pollution emissions associated with federal electricity consumption by purchasing electricity from emerging renewable energy sources that are certified by a third party as having low environmental impact.

Under the Green Power Initiative, NRCan purchases electricity generated from renewable energy sources and encourages other federal departments to do the same. NRCan has pledged to purchase 20 percent of its electricity from new green power sources by 2010, wherever it makes economic sense. NRCan made its first green power purchase in Alberta in 1998.

Key 2001–2002 Achievements

- The Government of Canada began receiving electricity from emerging renewable energy sources in Saskatchewan and Prince Edward Island in 2001.
- The government of Prince Edward Island is purchasing electricity from emerging renewable energy sources for its own facilities.
- The 5.3-megawatt wind farm in Prince Edward Island was built in the fall of 2001.
- A Memorandum of Understanding with Nova Scotia Power was extended to allow for continuing negotiations toward a purchase of electricity.

For more information:
nrcan.gc.ca/redi

Renewable Energy Programs: **Photovoltaic and Hybrid Systems Program**

Objective: To support the development and application of solar photovoltaic (PV) technologies in Canada.

Program expertise is available for technical and economic studies for PV systems, the development and testing of PV systems components, the design and optimization of PV-genset hybrid systems and their application in cold climates, the development of product standards and electrical installation codes and the development of advanced modelling and simulation software tools. The program also supports the development of grid-connected applications in Canada, including the building of integrated PV systems.

- Growth of PV applications in Canada has averaged 25 percent per year over the last eight years, with an installed power capacity reaching 8.1 megawatts in 2001. PV systems have been shown to operate reliably in many remote and off-grid applications in Canada.

Key 2001–2002 Achievements

- Signed an agreement to develop and demonstrate the first community-scale PV system integrated to residential rooftops in a neighbourhood in Canada (Kitchener-Waterloo, Ontario).
- Launched MicroPower Connect, with key players from industry and other federal departments, addressing the interconnection of issues of small distributed power sources (www.micropower-connect.org).
- Developed and hosted the international "Workshop on the Use of Photovoltaic Power Systems in Developing Countries" and the international "PV Horizon: Workshop on Photovoltaic Hybrid Systems."
- Safety improved for solar PV equipment and for the installation of PV power sources because of changes to the CSA C22.2 No. 107.1 ("General Use Power Supplies") standard and the Canadian *Electrical Code*.

For more information:
cetc-varennes.nrcan.gc.ca/eng/programmes_energies.html#photovoltaique

Renewable Energy Programs:
Renewable Energy Capacity-Building Program

Objective: To promote the deployment of renewable energy systems by building the capacity of planners, decision-makers and industry to implement more projects successfully.

The Renewable Energy Capacity-Building Program (RECAP) works to create knowledge through the development of enabling tools, knowledge transfer to clients and providing project implementation support in high-priority markets, such as Canadian remote communities and federal facilities.

- Since the initial release of the software in May 19[illegible] the RETScreen® International Renewable Energy Project Analysis Software has more than 20 000 users in 185 countries. Demand for the software has been growing at more than 150 new users per week. In 2001 the RETScreen® Web site had more than 4 million "hits."

Key 2001–2002 Achievements

- RECAP team received the 2001 Head of the Public Service Award for Excellence in Service Delivery. The team developed the RETScreen® International Renewable Energy Project Analysis Software, working with a network of experts from across Canada and around the world.
- Trained more than 650 Canadians at 25 renewable energy training seminars across the country in collaboration with the Renewable Energy Deployment Initiative, the Federal Buildings Initiative and the Aboriginal and Northern Climate Change Program.
- Provided project implementation support to more than 50 potential renewable energy projects at federal and municipal government facilities and in Aboriginal and northern communities.

For more information:
retscreen.net

Renewable Energy Programs:
Renewable Energy Deployment Initiative (REDI)

Objective: To stimulate the demand for renewable energy systems by helping the supply industry in its marketing and infrastructure development efforts, including the provision of financial incentives.

REDI targets four systems: solar water-heating, solar air-heating, earth energy and high-efficiency, low-emissions biomass combustion. REDI promotes these systems in the business, federal and non-business markets, mainly through financial incentives, marketing and infrastructure development.

Key 2001–2002 Achievements

- $1.2 million in REDI financial incentives was distributed among a total of 49 projects valued at $5.5 million; the projects were completed in 2001–2002.
- Officially announced the new CSA standard C448 Series-02, "Design and Installation of Earth Energy Systems."
- Helped a federal organization and other entities to implement their renewable energy initiatives, including an innovative project for an ocean geothermal heat pump system.

TABLE 8-3

REDI for Business Projects Completed

	Number of projects completed	*NRCan contribution*
1998 – 1999	8	$141,055
1999 – 2000	9	$119,910
2000 – 2001	24	$1,849,918
2001 – 2002	49	$1,202,259
Total	**90**	**$3,313,142**

- Completed three solar pool-heating pilot projects in Quebec, Ontario and British Columbia to promote the use of unglazed solar collectors for residential pools.

For more information:
nrcan.gc.ca/redi

Renewable Energy Programs:
Renewable Energy Information and Awareness Program

Objective: To expand the use of renewable energy technologies and stimulate the growth of the renewable energy industry.

Program activities focus on examining the information needs of market participants (i.e., potential users of renewable energy and the renewable energy industry) and preparing specialized information to show how renewable energy technologies can economically and reliably help meet Canada's energy needs.

Key 2001–2002 Achievements

- Introduced, sometimes in collaboration with allies, several new publications on renewable energy technologies, including:
  - *An Introduction to Photovoltaic Systems*
  - *Photovoltaic Systems: A Buyer's Guide*
  - *Discover the Uses of Landfill Gas*
  - *Residential Earth Energy Systems: A Buyer's Guide*
  - *Earth Energy Case Study: Ground-source heat pumps produce savings for commercial building*
- Held five workshops in various regions to raise awareness and encourage renewable energy technology in the institutional and commercial sectors, including in national parks.
- Sponsored two geoexchange workshops in March 2002 to address questions related to the capabilities and efficiencies of geoexchange systems.

For more information:
canren.gc.ca

Renewable Energy Programs:
Renewable Energy Market Assessment Initiative

Objective: To review renewable energy resources and use and to determine the potential market for commercially available technologies for meeting Canada's energy needs and environmental goals.

Initiative activities include compiling data on demand and supply constraints, evaluating market prospects for existing and new technologies and developing strategies to increase the capacity of the renewable energy industry to meet demand in identified markets.

Key 2001–2002 Achievements

- Eight residential wood-heating pilot projects took place across Canada, with the educational portion sponsored by NRCan, to encourage Canadians to burn wood cleaner, safer and more efficiently.
- Conducted three workshops for the advancement of solar energy and other renewable energies in national parks. A network of parks' renewable energy champions was initiated, and negotiations are ongoing to incorporate renewable energy into park operations.
- Worked with the Canadian Electricity Association and the Geothermal Heat Pump Consortium, Inc. to consolidate efforts in the promotion of geoexchange systems.

For more information:
nrcan.gc.ca/redi

Renewable Energy Programs: Renewable Energy Technologies Program

Objective: To support efforts by Canadian industry to develop renewable energy technologies.

Technologies supported include bioenergy (combustion, biochemical conversion of biomass to ethanol, thermochemical conversion of biomass to bio-oil and biogas, and biomass preparation and handling), small hydro projects (less than 20 megawatts), active solar applications and wind energy. Activities are directed toward improving the reliability and lowering the cost of technologies, disseminating information on technology feasibility and economics to potential users and helping industry commercialize its products in domestic and foreign markets.

- With ongoing support from NRCan dating back to the early 1980s, Conserval Engineering Inc. developed SOLARWALL® – the world's most efficient solar air heating system.
- With NRCan and other federal support, Iogen Corporation developed and demonstrated a cost-effective process for the production of ethanol from biomass, including existing agricultural residues. Iogen anticipates this technology will lead to the widespread use of 10 percent ethanol, blended with gasoline, as a motor vehicle fuel in Canada.

Key 2001–2002 Achievements

- NRCan's new 200-kilowatt indoor solar simulator lamp, the world's largest, opened for business at the National Solar Test Facility – North America's leading centre for testing and rating technologies under controlled sunlight and temperature conditions.
- Signed agreement with Vergnet SA of France to transfer its 10- and 60-kilowatt wind turbine technology to its new subsidiary, Vergnet Canada Ltd., so that the turbines will be manufactured in Canada.
- Université Laval's Mechanical Engineering small hydro turbine laboratory test-bench facility, developed in partnership with NRCan, expanded its analysis capacity.
- Established a Web site for the Canadian Renewable Energy Network.

For more information:
cetc-varennes.nrcan.gc.ca/eng/programmes_energies.html

Community Energy Systems: **Community Energy Systems Program**

Objective: To increase the sustainability of Canadian communities by addressing their energy needs.

In partnership with Canadian communities and businesses, energy needs are addressed through a holistic approach to energy efficiency, renewable energy and community energy planning.

- NRCan has supported many district energy projects, some of which are based on renewable energy, including Charlottetown, Prince Edward Island – biomass and municipal waste fuelled; Fort McPherson, Northwest Territories – cogeneration; Cornwall and Sudbury, Ontario – cogeneration; Windsor and Hamilton, Ontario – cogeneration, heating and cooling; Ajax, Ontario – using waste wood from industry; and Watson Lake, Yukon Territory, and Arviat, Nunavut, and many other northern communities – using waste energy from the local power plants.
- NRCan helped design a heating system for the Cree community of Ouje-Bougoumou, in northern Quebec. The system uses sawdust from a local sawmill to provide over 90 percent of the energy required using oil as a backup. Carbon dioxide emissions have been reduced by an estimated 2300 tonnes per year.

Key 2001–2002 Achievements

- Developed a community energy training program and piloting of workshops in Regina, Saskatchewan, and Halifax, Nova Scotia.
- Sponsored the Canadian District Energy Association Conference, focusing on raising awareness of the benefits of district energy.
- Published technical guidebook *District Energy – Biomass and Your Community*, covering initial steps in assessing the feasibility of biomass district energy.
- Produced two International Energy Agency reports: *District Heating and Cooling Connection Handbook* and *Optimization of District Heating Systems by Maximizing Building Heating System Temperature Difference*.
- Sponsored, with U.S. Department of Energy, the 2nd Annual Workshop on Microturbine Applications. Microturbines offer increased energy efficiency and potential to generate heat and power on-site.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_ces_e.html

Chapter 9: Federal House in Order

Introduction

The Government of Canada is the country's largest single enterprise. It is working to get its own house in order by setting a target of 31 percent reduction in greenhouse gas (GHG) emissions from its own operations by 2010.

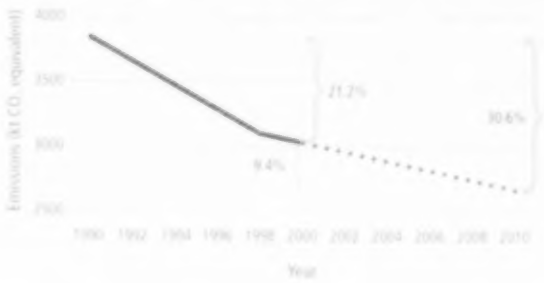
Since 1990, through building retrofits, better fleet management, strategic "green power" purchases and the downsizing of operations, the Government of Canada has already achieved a 21 percent emissions reduction. The Government of Canada will reduce its emissions by a further 12 percent by 2010.

The Government of Canada will achieve its goal by additional building retrofits, fuel switching and increased use of renewable energy within government operations. Moreover, the government can help to "create the market" for certain new technologies on the verge of becoming viable. Key departments, which are responsible for 95 percent of government GHG emissions, have been assigned specific targets and must report annually on their progress.

The task of target sharing has been undertaken by means of a three-year action plan and entails assigning specific targets to the 11 key departments. Natural Resources Canada (NRCan) is taking a lead role in managing this task and in providing the services to departments and agencies that will help them achieve their targets. The Leadership Challenge encourages the reduction of all federal emissions by engaging the active participation of the departments, agencies and Crown corporations that were not designated with a target.

FIGURE 9-1

GHG Emissions Reductions from All Federal Operations



The Federal House in Order initiative consists of various complementary activities, including GHG inventory and tracking, purchases of emerging renewable electricity or Green Power and efforts to reduce "outside emissions" (a pilot project for transit pass through payroll deduction for federal employees was launched October 2002), and three supporting programs:

- Federal Buildings Initiative;
- Federal Industrial Boiler Program; and
- Federal Vehicles Initiative.

Federal Buildings Initiative (FBI)

Objective: To assist Government of Canada departments and agencies to implement energy efficiency improvements, leading to reduced GHG emissions and operating costs.

The FBI provides services to help implement comprehensive energy efficiency improvements. These include advice and consultation on organization readiness and project design; lists of energy management firms qualified to build projects; project financing options; a national network for energy management training; model tendering documents; and employee awareness products.

Key 2001–2002 Achievements

- Initiated and registered retrofits of 7000 federal buildings and other facilities, reducing GHG emissions significantly and generating annual savings of $27 million.

For more information:
oee.nrcan.gc.ca/fbi/home_page.cfm

FIGURE 9-2

FBI Investment and Energy Savings

Federal Industrial Boiler Program (FIBP)

Objective: To help clients increase energy efficiency, reduce carbon dioxide (CO_2) and nitrogen oxide (NO_x) emissions and extend the useful life of existing heating and cooling systems.

FIBP encourages its clients to consider energy-efficient and environmentally responsible technologies when replacing or modifying central heating and cooling plants. Services delivered under FIBP help government departments and other clients adopt new heating and cooling technologies that could reduce NO_x emissions by 50 percent, increase energy efficiency by up to 15 percent and reduce operating costs by 20 percent, compared with conventional practices.

- FIBP clients have reduced energy consumption by 800 terajoules, CO_2 emissions by 45 kilotonnes and NO_x emissions by 100 tonnes.

Key 2001–2002 Achievements

- Public Works and Government Services Canada (PWGSC) and Health Canada optimized their boiler systems and were given alternatives for humidification.
- Optimized building mechanical systems at Canadian embassies – in New Delhi, India; Washington, D.C., United States; and Tokyo, Japan.
- Coordinated installation of a standby power facility for Agriculture and Agri-Food Canada (AAFC), including new building construction and installation of two diesel-fired generators.
- Identified energy saving opportunities (cogeneration, lighting, building automation controls) for Communications Research Centre Canada, Shirleys Bay, Ontario.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_fibp_e.html

FIGURE 9-3

Energy Savings from FIBP, 1991–1992 to 2001–2002

Federal Vehicles Initiative

Objective: To assist Government of Canada departments increase the energy efficiency of their motor vehicle fleets, reduce the environmental impact of federal vehicle operations and promote the *Alternative Fuels Act* within the federal fleet.

The Initiative provides fleet managers with an assessment of fleets as well as technical advice and encouragement on acquiring and using alternative transportation fuels (ATFs). Four departments participate in planning and reporting on the initiative: Treasury Board of Canada Secretariat, NRCan, Environment Canada and PWGSC.

Key 2001–2002 Achievements

- Agreement with Canada Safety Council to include energy efficiency content in the 2002 version of the Defensive Driving Course; Department of National Defence, Canadian Food Inspection Agency/AAFC and Correctional Service of Canada to use this course for all drivers.
- By fall 2001, three new executive vehicles using ATFs.

For more information
oee.nrcan.gc.ca/greening

FIGURE 9-4

Federal Fleet Size and Fuel Consumption, 1995–1996 to 1999–2000

FIGURE 9-5

Purchase of ATF Vehicles for the Federal Fleet

Chapter 10: Intergovernmental Cooperation

Introduction

This chapter describes Natural Resources Canada's (NRCan's) intergovernmental cooperation with respect to efficiency and alternative energy (EAE) during the reporting period at three levels: municipal, provincial/territorial and international. Other examples of intergovernmental cooperation are set out in previous chapters in the Key Achievements sections of specific EAE program initiatives.

Federal-Provincial and Federal-Territorial Cooperation

Provincial and territorial governments delivered a substantial number of EAE programs during the reporting period in order to reduce energy costs, increase competitiveness, improve air quality and generate economic and trade opportunities. Coordination between the federal and provincial/territorial levels is essential to avoid duplication and ensure efficient program delivery. During the reporting period, the governments cooperated at the general level and at the level of specific program initiatives.

General Cooperation

Cooperation Agreements

- NRCan had a Letter of Cooperation (LOC) on EAE with the Agence de l'efficacité énergétique du Québec during the reporting period. The LOC ensures an efficient consultation and exchange of information between the two governments, and it helps coordinating EAE activities in the province and creating opportunities for joint projects. The management committee established under the LOC met twice a year during the period to review policy and program developments, progress on joint program initiatives and areas for further cooperation.
- The LOC played a considerable role in facilitating the conduct of three activities in particular:
  - the management of the licensing agreement for the EnerGuide for Houses Program (which is delivered in Québec by the Agence de l'efficacité énergétique);
  - the conclusion of a contribution agreement between NRCan's Office of Energy Efficiency (OEE) and the Agence de l'efficacité énergétique under the Commercial Building Incentive Program regarding projects submitted to NRCan by public organizations in Québec. The cooperation framework that was agreed upon in February 2000 is now being applied to other NRCan energy sector programs aimed at the public sector in Québec; and
  - the management of the agreement between NRCan (CANMET Energy Technology Centre – Varennes, Québec) and the Agence de l'efficacité énergétique relating to the Programme d'intervention en réfrigération dans les arénas du Québec. Among activities, an important study was completed to evaluate the potential energy savings and greenhouse gas emissions reduction in Québec's arenas.
- Another LOC on energy efficiency and renewable energy was signed in 2001 between the Government of Canada and the Government of Yukon with similar objectives, i.e., facilitating information exchange and creating opportunities for joint projects in Yukon Territory. The first project under the LOC was the creation of a joint Energy Solutions Centre in Whitehorse, Yukon Territory, which started its operations in December 2000. The Centre provides access to relevant technical services to the Yukon population, undertakes outreach and public education activities and delivers assigned energy efficiency and renewable energy programs in Yukon Territory.

National Advisory Council on Energy Efficiency (NACEE)

- NRCan created NACEE in April 1998 to advise and guide the OEE on the most effective way to achieve its mission. During 2001–2002, NACEE members included representatives from four provinces – Manitoba, New Brunswick, Quebec and Saskatchewan – who had the opportunity to comment on the OEE's business plan and programs.

Cooperation at the Program Level

R-2000 Initiative

- In 2001–2002, the R-2000 Initiative was delivered in seven provinces (Alberta, Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario and Saskatchewan) and in Yukon Territory. Provincial home builders' associations, except in Manitoba and Yukon Territory, participated in the delivery of the program. There were three types of cooperation during the period:
  - Representatives from most provinces and Yukon Territory participated as members of regional R-2000 advisory committees;
  - In New Brunswick, Newfoundland and Labrador, Nova Scotia and Saskatchewan, the provincial governments and NRCan supported the program through financial or in-kind contributions; and
  - In Manitoba and Yukon Territory, the provincial and territorial governments delivered the program under a licensing agreement with NRCan.

EnerGuide for Houses Program

- Several provinces and Yukon Territory participated in the EnerGuide for Houses Advisory Committee.
- Yukon Housing Corporation and the Agence de l'efficacite energetique du Quebec are the delivery agents of the program in their jurisdictions, under licensing agreements with NRCan.

Federal Buildings Initiative (FBI)

- British Columbia and New Brunswick have replicated a number of elements of FBI into programs aimed at improving the energy efficiency and environmental performance of their buildings inventories.

Commercial Building Incentive Program (CBIP)

- Provinces and territories distributed information on CBIP. Provincial and territorial health and education departments were active participants in the program as eligible parties.

Canadian Industry Program for Energy Conservation (CIPEC)

- The excellence of the CIPEC concept and its ability to instigate positive change was affirmed when India chose the CIPEC model as the basis for the Indian Industrial Programme for Energy Conservation (IIPEC). Following CIPEC's lead, IIPEC is establishing a series of energy management sector task forces, including cement, pulp and paper and textiles.

In April 2002, representatives of IIPEC toured Canadian facilities of CIPEC partners in Ontario and Quebec, joined a CIPEC Cement Task Force meeting and met with officials from the OEE and other federal departments, non-governmental organizations, academia and research labs. Two participants from the Indian delegation attended an OEE customized "Dollars to $ense" textile workshop.

Energy Innovators Initiative (EII)

- EII relies on partners to promote energy efficiency and facilitate access to its members as well as to provide sectoral information. Partners include the Association of Canadian Community Colleges, the Canadian School Boards Association, the Canadian College of Health Service Executives, the Association des gestionnaires de parcs immobiliers institutionnels, the Hotels Association of Saskatchewan, the Alberta Hotel & Lodging Association, the Manitoba Hotel Association and the British Columbia & Yukon Hotels' Association. As well, a dynamic partnership has been established with BC Hydro to assist in identifying new retrofit projects with large energy users. Additionally, the EII works with the Agence de l'efficacité energétique du Québec to facilitate program delivery to the province's institutional sector.

Equipment Energy Efficiency Regulations

- NRCan and five provinces (British Columbia, New Brunswick, Nova Scotia, Ontario and Quebec) regulate the energy efficiency performance of prescribed equipment. They share information and consult through CSA International's Advisory Committee on Energy Efficiency.

Green Power Initiative

- The February 2000 federal budget announced that the Government of Canada would expand the pilot Green Power Initiative to procure $15 million of renewable energy over the next 10 years in Saskatchewan and Prince Edward Island. NRCan entered into discussions with SaskPower and Maritime Electric on the purchase of green power for federal facilities in the provinces they serve.

Residential Wood Combustion

- NRCan is a member of the Intergovernmental Working Group on Residential Wood Combustion, which is co-chaired by Environment Canada and the Newfoundland and Labrador Department of Environment. The Federal Smog Management Plan calls for four initial joint actions on residential wood combustion:
  - assess the effectiveness of pilot wood stove change-out programs and consider options for a national program;
  - complete an update of CSA International standards on wood stoves, fireplace inserts and solid-fuel-burning central systems, and further the development of similar standards for fireplaces;
  - support public education on cleaner wood burning with advanced technologies and sustainable wood use; and
  - develop a federal regulation on residential wood combustion, focusing on cleaner burning appliances.
- NRCan chairs the cross-jurisdictional steering committee developing a Canada-wide education campaign on safe, clean and efficient residential wood heating. NRCan worked with health industry partners, the Canadian Lung Association, the Canadian Environmental Network and Fire Prevention Canada in preparation of the initial launch of the campaign in fall 2002.

Personal Vehicle Program

- NRCan successfully partnered with the City of Mississauga, Ontario, to pilot a municipal-based awareness campaign promoting the benefits of not idling vehicles needlessly. The two-year pilot will lay the groundwork for a national campaign, which will also provide municipalities, community groups and individuals with a "tool kit" of information to launch their own anti-idling campaigns.
- NRCan collaborated with the Agence de l'efficacite energétique du Québec, along with federal and industry partners, on a series of citizen engagement forums across the country. The goal of the forums was to identify barriers and motivators that could help Canadians reduce the environmental impacts of their driving while also reducing their transportation costs.

Federal-Municipal Cooperation

- The town of Banff, Alberta, mandated the R-2000 Standard for new residential construction by the Banff Housing Corporation.
- A number of municipalities received financial incentive contributions in 2001–2002 under CBIP.
- A number of municipalities registered as Energy Innovators during the period, and some received financial assistance under the EII.

Green Municipal Funds

- The Green Municipal Funds were created in Budget 2000 by an endowment of $125 million to the Federation of Canadian Municipalities (FCM). The funds were doubled in Budget 2001 to the current total of $250 million – $50 million for the Green Municipal Enabling Fund (GMEF) and $200 million for the Green Municipal Investment Fund (GMIF).

- Cooperation takes place on several levels in the delivery of the Green Municipal Funds:
  - The Government of Canada signed an Agreement with the FCM, a non-profit organization, to deliver the Green Municipal Funds.
  - Moneys for the Green Municipal Funds endowment were provided equally by NRCan and Environment Canada who signed a Memorandum of Understanding.
  - Provincial, territorial and municipal officials cooperate to promote projects with innovative environmental solutions within municipalities across Canada because each municipal application must be accompanied by a provincial or territorial letter of support.
  - The Government of Canada shares in the governance of the Green Municipal Funds, along with representatives from both the public and private sectors, including municipal officials and technical experts, through participation on a Peer Review Committee and a governing Council.

International Cooperation

NRCan also cooperates with several international organizations and foreign governments. Canada benefits from this cooperation in two ways:

- Canada learns about improved ways of designing and delivering EAE programs; and
- this cooperation helps to reduce trade barriers to energy-using products through the harmonization of energy efficiency tests and performance standards.

International Energy Agency (IEA)

Canada is a member of the IEA, an autonomous agency linked with the Organisation for Economic Co-operation and Development (OECD).

On the policy side, NRCan serves on a number of committees that review policies and undertake studies on energy efficiency and related issues. These committees include the Standing Group on Long-Term Cooperation (SLT) and the Energy Efficiency Working Party (EWP), which reports to the SLT. The SLT develops policy analyses to promote conservation and the efficient use of energy, whereas the EWP/SLT carries out more detailed studies on specific energy efficiency issues.

Canada is an active member of the Centre for Analysis and Dissemination of Demonstrated Energy Technologies (CADDET). CADDET is an international information network to help managers, engineers, architects and researchers find out about energy-using technologies that have worked in other countries. Canada cooperated with some 11 OECD countries during the reporting period.

Canada also collaborates with research centres in member countries on several agreements and programs of the IEA oriented toward research and development (R&D) and technology.

Asia-Pacific Economic Cooperation (APEC)

Since the first meeting of APEC Energy Ministers in August 1996, NRCan has played a leading role in efforts to ensure that efficiency test standards for energy-using appliances do not become barriers to trade within the APEC region. Acting on the ministers' directions, NRCan has chaired the APEC Energy Working Group's Steering Group on Energy Standards since 1996. In 2000, the work plan of this working group was incorporated into that of the Expert Group on Energy Efficiency and Conservation.

During the reporting period, the group started investigating the prospects for developing ways to determine energy performance by one test procedure (from the results generated by testing another test procedure). This investigation focused on domestic refrigerators and air conditioners. Additional studies were initiated to survey manufacturers and regulators regarding the acceptance of these results. Reports are expected to be finalized in the third quarter of 2001/2002.

Also under the APEC Energy Working Group, NRCan participates in the Expert Group on New and Renewable Energy Technologies. Activities of the working group during the reporting period included exchanging information on new and renewable energy technology programs, technologies and R&D strategies; fostering cooperation in priority areas; conducting technology transfer seminars; analysing projects for APEC funding; and monitoring progress in the accepted projects. On the domestic side, NRCan provided information to interested Canadian parties in the private sector and government on opportunities for collaboration, potential opportunities for technology transfer and information exchange, and upcoming APEC seminars.

Hemispheric Energy Initiative

The Hemispheric Energy Initiative (HEI) is the energy component of the action plan arising from the Summit of the Americas and supporting the Hemispheric Energy Ministers meetings. The aim of the HEI is to advance sustainable development and use of energy in the hemisphere. The HEI has eight "outcomes," one of which is promotion of energy efficiency in the hemisphere. NRCan leads one component of this outcome – promotion of energy efficiency in equipment and buildings.

Research and Development

NRCan facilitates R&D and commercial business ventures abroad by Canadian firms by undertaking a wide variety of activities, including participating in various IEA tasks and supporting technical and trade-oriented workshops and conferences.

Mexico

NRCan signed a Memorandum of Understanding (MOU) on EAE cooperation with the Mexican Energy Secretariat in June 1996. The objective of the MOU is to contribute to the EAE objectives of both countries by:

- improving the design and delivery of EAE programs implemented or sponsored by NRCan and Mexico's National Commission for Energy Savings (Comision Nacional para el Ahorro de Energia [CONAE]); and
- enhancing trade, investment and exchanges (technical and other) related to energy-efficient products, energy management services and alternative energy goods and services.

Bangladesh

NRCan and Environment Canada led a technical training project with the Bangladesh State Gas Company, at the request of the Government of Bangladesh. An agreement was signed with BC Gas International Inc. to provide technical training to personnel from Bangladesh on the use of compressed natural gas as a transportation fuel. Funding was provided by the United Nations Development Programme with extensive in-kind contributions coming from Canadian industry.

Poland

NRCan, through the Program of Energy Research and Development, is supporting a small hydro project in Poland. The project also received financial support from the Technology Early Action Measures (TEAM) component of the Climate Change Action Fund. Located on the Odra River, near Opole, Poland, the three-site project will provide 4.5 MW of energy and is expected to be completed and commissioned by June 2004. The project is a joint venture between a Canadian partner (ESI Ecosystem International ltd.) and a Polish partner (Pump Storage Power Plants Co.).

United Kingdom

NRCan, working with Canada Mortgage and Housing Corporation, the Canadian High Commission, a Canadian builder and a U.K. builder, brought the Super E™ housing program to the United Kingdom. Herb Dhaliwal, the Minister of Natural Resources Canada, officially opened the first house, with many more being built. The Super E™ House Program is a strategic housing export initiative delivered by NRCan as part of the Team Canada inc. export strategy.

United States

Motor Vehicle Fuel Efficiency and Fuels – In March 1996, NRCan and the U.S. Department of Energy signed an MOU concerning road transportation, energy efficiency and alternative fuels. The MOU provides a formal mechanism for negotiating and harmonizing North American policy on fuel efficiency, as both nations consider options in responding to their respective climate change commitments.

Three important studies are now being conducted under the MOU. The first study aims at developing an analytical framework for estimating the technological response to any new initiative to improve the fuel economy of future new vehicles, and applying the framework to assess the impact on three selected manufacturers and their products. The second study analyses the emissions reduction potential of gas and diesel engines in North America. The third study analyses the potential costs and benefits of the 42-volt hybrid system for vehicles.

United States and Mexico

NRCan participates with the United States and Mexico in the North American Energy Working Group's Energy Efficiency Experts Group to promote the harmonization of energy efficiency test methods, mutual recognition of conformity assessment systems for energy efficiency standards and cooperation on trilateral energy efficiency labelling programs. During the review period, test standards for three products were assessed, and equivalent standards of performance were then instituted in Mexico. Work has begun to determine the prospects for the participation of Mexico in the Energy Star® high-efficiency program currently promoted in Canada and the United States.

Appendix 1:
NRCan's Efficiency and Alternative Energy Initiatives and Expenditures, 2001–2002

	(millions of dollars)
General Programs	6.22
Outreach	
National Energy Use Database	
Community Energy Systems Program	
Energy Efficiency – Equipment	5.26
Energy Efficiency Standards and Regulations	
Labelling and Promotion	
EnerGuide for Houses	
EnerGuide for Industry	
Mine Ventilation	
Water-Powered Hydraulic Drill	
Energy Efficiency – Buildings*	35.52
R-2000 Standard	
Super E™ Program	
Commercial Building Incentive Program	
Industrial Building Incentive Program	
Federal Buildings Initiative	
Federal Industrial Boiler Program	
Green Buildings	
Energy Innovators Initiative	
Buildings Program	
Simulation	
Bringing Energy Efficient Technologies to Market	
Energy Efficiency – Industry	38.69
Industrial Energy Efficiency (Canadian Industry Program for Energy Conservation; Industrial Energy Innovators)	
Advanced Combustion Technologies	
Processing and Environmental Catalysis Program	
Industrial Process Engineering Program	
Industrial Process Integration Program	
Industry Energy Research and Development Program	
Emerging Technologies Program	
Energy Technologies for High-Temperature Processes	
International Centre for Sustainable Development of Cement and Concrete	

	(millions of dollars)
Energy Efficiency – Transportation	12.46
Vehicle Efficiency Targets	
Personal Vehicle Program	
Fleet Vehicle Program	
Federal Vehicles Initiative	
Canadian Lightweight Materials Research Initiative	
Alternative Energy – Transportation	3.90
Fuel-Cell-Powered Mining Vehicles	
Vehicle Fuels	
Transportation Energy Technologies Program	
Alternative Energy – Renewable Energy Sources	17.31
ENFOR (ENergy from the FORest)	
Green Power Initiative	
Photovoltaic and Hybrid Systems Program	
Renewable Energy Capacity Building Program	
Renewable Energy Deployment Initiative	
Renewable Energy Information and Awareness Program	
Renewable Energy Market Assessment Initiative	
Renewable Energy Technologies Program	
Total*	119.36

*In addition to the resources cited here, $12.5 M and $50 M were provided to the Green Municipal Enabling Fund and the Green Municipal Investment Fund, respectively, which are managed by the Federation of Canadian Municipalities.

Appendix 2:
Data Presented in the Report

The aggregate energy use data presented in this report are taken from Statistics Canada's *Quarterly Report on Energy Supply-Demand in Canada* (QRESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of QRESD energy use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report uses a definition better suited for the purpose of energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix C of NRCan's *Energy Efficiency Trends in Canada 1990 to 1999*.

FIGURE 2-1: Secondary Energy Use and Energy Savings Due to Energy Efficiency, 1990 to 2000 (index 1990 = 1.0)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Actual energy use	1.00	0.98	1.00	1.02	1.06	1.07	1.11	1.12	1.09	1.13	1.17
Energy use without efficiency improvement	1.00	0.99	1.02	1.05	1.09	1.12	1.15	1.17	1.16	1.21	1.26

FIGURE 2-2: Net Solar, Wind, Wood and Waste Electric Power Consumption in Canada

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Terawatt hours (billions of gigawatt hours)	missing	4.1	4.5	5.4	5.3	5.5	5.9	6.3	7.0	9.0

FIGURE 4-1: Canadian Households by Type of Dwelling, 2000 (percent)

Single detached	55.53
Apartments	31.68
Single attached	10.60
Mobile homes	2.19

FIGURE 4-2: Residential Energy Use by Purpose, 2000 (percent)

Space heating	62.73
Water heating	20.38
Appliances	11.18
Lighting	4.88
Space cooling	0.82

Figure 4-3: Residential Energy Use and Energy Savings Due to Energy Efficiency, 1990 to 2000 (index: 1990 = 1.0)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Actual energy use	1.00	0.98	1.01	1.04	1.07	1.04	1.12	1.08	0.98	1.02	1.07
Energy use without efficiency improvement	1.00	1.04	1.10	1.14	1.15	1.17	1.22	1.19	1.10	1.15	1.22

FIGURE 4-4: Annual Heating Costs for Houses Constructed to Different Standards, 1999 (dollars per year)

Typical existing house (1970)	1790
Typical new house (1999)	1134
Model National Energy Code house (1999)	897
R-2000 house	707

FIGURE 4-5: Average Energy Consumption per Household (EnerGuide for Houses Program and R-2000 Initiative) (gigajoules)

Year Built	Average Energy Consumption	Average EGH Rating
R-2000	96.91	81.61
Canada	198.70	62.49
2001-2010	132.61	74.46
1991-2000	148.20	71.61
1981-1990	180.57	66.91
1971-1980	191.86	63.80
1961-1970	196.89	62.64
1946-1960	206.54	60.91
Pre-1946	272.33	49.68

FIGURE 4-6: R-2000 Share of National Housing Completions, 1990 to 2000 (percent)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
R-2000 Share	0.279	0.333	0.673	0.959	0.5604	0.534	0.331	0.341	0.265	0.154	0.182

FIGURE 4-7: National Trends in Air Leakage in Houses

Year Built	Air Changes per Hour at 50 Pa, Averaged Over 10-Year Construction Period
R-2000	1.27
2001-2010	3.26
1991-2000	5.32
1981-1990	5.32
1971-1980	6.42
1961-1970	6.55
1946-1960	7.82
Pre-1946	10.73

FIGURE 4-8: Homes Evaluated and Labelled Under the EnerGuide for Houses Program

	A evaluation	B evaluation	Total
2001 – 2002	11 087	709	11 796
2000 – 2001	11 509	607	12 116
1999 – 2000	9 106	225	9 331
1998 – 1999	3 672	832	4 504

Under the EnerGuide for Houses Program, homes are evaluated to determine the potential for energy savings (an A evaluation). After renovations implementing program recommendations have taken place, some homes are revisited to determine the actual energy savings (a B evaluation).

FIGURE 4-9: Residential Energy Use and Energy Savings per Household (gigajoules per year per house)

	Energy Use Pre-Audit	Identified Energy Savings Potential	Actual Energy Savings Implemented
Average	198	48	26
2000–2002	180	77	42
1990–1999	150	34	10
1980–1989	188	33	16
1970–1979	199	49	27
1960–1969	195	46	26
1945–1959	187	46	25
Pre 1945	254	75	47

FIGURE 4-10: Share of Residential Energy Consumption Subject to *Energy Efficiency Regulations*, 1999 (petajoules)

	Regulated	Unregulated
Space conditioning	556.0	223.0
Water heating	296.0	0.5
Appliances and lighting	117.0	133.0
Total	**970.0**	**357.0**

FIGURE 4-13: Average Energy Consumption of New Appliances: 1990 and 2000 Models (kilowatt hours per year)

Appliance Type	1990	2000
Clothes washers	1218	838
Clothes dryers	1103	910
Refrigerators	956	640
Dishwashers	1026	637
Ranges	772	760
Freezers	714	391

FIGURE 4-15: Total Energy Savings and GHG Emissions Reductions Attributable to the EnerGuide for Equipment Program, 1990 to 2000 (GWh/kt CO_2e)

Year	Total Energy Savings (GWh)	Reduced GHG Emissions (kt CO_2e)
1990	16.4	8.9
1991	21.7	11.8
1992	40.1	21.7
1993	41.9	22.6
1994	43.2	23.4
1995	40.3	21.8
1996	43.7	23.7
1997	46.7	25.3
1998	62.4	33.8
1999	83.8	45.4
2000	91.1	49.3
Cumulative Annual	**531.3**	**287.8**

FIGURE 5-1: Commercial and Institutional Energy Use by Building Type, 2000

Building Type	Energy Use (PJ)	Percent
Retail	257.37	24.43
Office	259.23	24.65
School	146.46	13.93
Health	123.72	11.77
Hotel and restaurant	91.70	8.72
Recreation	64.12	6.10
Warehouse	52.12	4.96
Other institutional	44.65	4.25
Religious	12.12	1.15
Total	**1051.50**	

FIGURE 5-2: Commercial and Institutional Energy Use by Purpose, 2000

Building Type	Energy Use (PJ)	Percent
Space heating	536.00	50.97
Lighting	152.91	14.54
Auxiliary motor	126.65	12.04
Water heating	107.23	10.20
Auxiliary equipment	80.86	7.69
Space cooling	47.85	4.55
Total	**1051.50** (excluding street lighting, 7.35 PJ)	

FIGURE 5-3: Commercial and Institutional Energy Use and Energy Savings Due to Energy Efficiency, 1990 to 2000 (Index: 1990 = 1.0)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Actual energy use	1.00	1.03	1.04	1.08	1.07	1.11	1.14	1.15	1.09	1.15	1.23
Energy use without efficiency improvement	1.00	1.05	1.06	1.10	1.10	1.12	1.14	1.14	1.11	1.17	1.25

FIGURE 5-4: Energy Use in Commercial Buildings, 1999
(megajoules per m^2 per year)

C-2000 projects	553
CBIP target	829
Model National Energy Code for Buildings	1105
New buildings	1328
All buildings	1585

1990 – 1999

Source: Commercial and Institutional Building Energy Use Survey, 2000. Estimates relate only to the surveyed area of populations over 170 000 and in Atlantic Canada populations of over 50 000.

FIGURE 5-5: Market Penetration of Energy Innovators Initiative in Commercial and Institutional Sectors

Year	Market Share (%)	Percentage Change
2001 – 2002	33.5	30.86
2000 – 2001	29.9	16.80
1999 – 2000	28.4	10.94
1998 – 1999	25.6	

Percentage change as compared with base year of 1998 – 1999

Note: The percentage penetration (i.e., sector penetration) is based on floor space and not energy bills.

FIGURE 5-6: Average GHG Reductions by Institution Under CBIP, 2002

Building Type	Average GHG Savings (tonnes/year)
Office	203.17
Health	164.39
MURB	147.80
Education	130.86
Retail	116.33
Other	62.09

FIGURE 5-7: Estimated Energy Savings from Motor Regulations, 2000 to 2020 (petajoules per year)

	2000	2005	2010	2020
Industrial energy savings	2.2	5.9	9.5	11.0
Commercial energy savings	2.1	4.6	6.8	6.7

FIGURE 6-1: Industrial Energy Use by Subsector, 2000

Industry Subsector	Percent of Industrial Energy Use
Forestry	0.5
Construction	1.6
Cement	2.1
Smelting and refining	7.1
Chemicals	7.5
Iron and steel	8.0
Petroleum refining	9.3
Mining	15.3
Other manufacturing	18.7
Pulp and paper	30.0

FIGURE 6-2: Cost of Energy to Industry as a Percentage of Total Production Cost, 1998

Industry Subsector	Energy Cost/ Total Production Cost
Transportation equipment manufacturing	0.70
Petroleum refining	2.19
Pulp and paper and wood industries	7.27
Iron and steel	9.68
Chemicals	9.94
Aluminum	17.83
Cement industry	35.21

FIGURE 6-3: Industrial Energy Use and Energy Savings Due to Energy Efficiency, 1990 to 2000 (Index: 1990 = 1.0)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Actual energy use	1.00	0.98	0.99	1.00	1.06	1.08	1.11	1.11	1.09	1.12	1.16
Energy use without efficiency improvement	1.00	0.98	1.00	1.02	1.08	1.11	1.12	1.15	1.15	1.20	1.25

FIGURE 6-4: Reduction in Energy Use per Unit of Output for Selected Industries, 1990 to 2000

Industry	Percent Reduction in Intensity
Pulp	5.91
Plastic and synthetic resin	2.49
Motor vehicle	6.67
Iron and steel	8.65
Cement	9.51
Construction	9.97
Aluminum	14.29
Meat and poultry	15.27
Plastic	16.74
Petroleum refining	20.26
Brewery	20.27
Organic chemicals	23.32
Furniture and fixtures	29.46
Motor vehicle parts and accessories	39.11
Beverage	41.21
Gold mines	47.14
Glass	50.90
Electric and electronic	75.90

FIGURE 6-5: Industrial Energy Innovators and Action Plans, 1995–1996 to 2001–2002

	Number of Innovators	Number of Action Plans and Progress Reports
2001–2002	24	126
2000–2001	53	93
1999–2000	14	75
1998–1999	6	99
1997–1998	5	56
1996–1997	27	151
1995–1996	173	24

FIGURE 6-6: Participation in CIPEC Program – Participation Level in Program Elements and Consequences to Energy Consumption

	Percent of CIPEC Participants
Heads Up CIPEC newsletter	59
CIPEC Web site	45
"Dollars to $ense" workshops	42
Boiler and Heater Guide	25
Motor Systems Assessment	25
Sector Energy Efficiency Guide	25
Employee Awareness kit	23
Sector benchmarking studies	20
CIPEC Task Force meetings	18
Energy Sector Days	10

	Mean 5-Year Increases in Energy Consumption, percentage
Participants	2.20
Energy Sector Days	5.20

FIGURE 7-1: Transportation Energy Use by Mode, 2000 (petajoules per year)

Passenger light vehicle	979.08
Freight truck	710.98
Passenger aviation	239.46
Freight marine	113.99
Freight rail	80.55
Passenger bus	73.19
Off-road	82.30
Passenger rail	2.53
Total	**2282.08**

FIGURE 7-2: Transportation Energy Use and Energy Savings Due to Energy Efficiency, 1990 to 2000 (index: 1990 = 1.0)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Actual energy use	1.00	0.96	0.99	1.00	1.05	1.07	1.09	1.13	1.17	1.20	1.22
Energy use without efficiency improvement	1.00	0.97	1.00	1.03	1.10	1.13	1.16	1.21	1.25	1.30	1.32

FIGURE 7-3: Market Shares of New Light Trucks and Passenger Cars, 1990 to 2000 (model year) (percent)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Light truck	30.47	30.17	30.34	33.08	34.81	35.69	39.19	42.63	43.18	41.51	40.77
Passenger car	69.53	69.83	69.66	66.92	65.19	64.31	60.81	57.37	56.82	58.49	59.23

FIGURE 7-4: New Car Fuel Efficiency, Normalized for Weight and Power, 1990 to 1999 (index: 1990 = 1.00)

	L/100 km	L/100 km/kg	L/100 km/hp
1990	1.000	1.000	1.000
1991	0.976	0.972	0.955
1992	0.988	0.989	0.924
1993	0.988	0.985	0.915
1994	1.000	0.956	0.901
1995	0.963	0.897	0.824
1996	0.963	0.914	0.807
1997	0.976	0.920	0.809
1998	0.976	0.928	0.798
1999	0.976	0.897	0.773

FIGURE 7-5: Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards (litres/100 km)

Model Year	Truck Standard (11.4 L/100 km)	Trucks CAFC	Car Standard (8.6 L/100 km)	Cars CAFC
1990	11.8	11.4	8.2	8.6
1991	11.6	11.1	8.0	8.6
1992	11.6	11.3	8.1	8.6
1993	11.5	11.1	8.1	8.6
1994	11.5	11.5	8.2	8.6
1995	11.4	11.5	7.9	8.6
1996	11.4	11.3	7.9	8.6
1997	11.4	11.3	8.0	8.6
1998	11.4	11.4	7.9	8.6
1999	11.4	11.3	7.9	8.6
2000	11.4	11.1	7.7	8.6
2001	11.4	11.1	7.9	8.6
2002	11.4	11.1	7.9	8.6

FIGURE 7-6: Vehicle Fuel Efficiency Awareness

Indicator	1998	1999	2001	2002
Awareness of the AutoSmart program (general public)	9%			16%
Recollection of information on how to reduce vehicle fuel consumption (general public)	30%			36%
Percentage of new vehicles in showroom with EnerGuide label		47%	56%	
Percentage of new vehicles in lot with EnerGuide label		64%	77%	

FIGURE 8-1: Canadian Wind Power Capacity, 1990 to 2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Megawatts	4.5	4.5	4.5	0.5	21.0	21.6	21.8	25.3	50.0	75.0	125.0

FIGURE 9-1: GHG Emissions Reductions from All Federal Operations

	1990	1998	2000	2010
Emissions (kt CO_2 equivalent)	3847	3102	3031	2671

FIGURE 9-2: FBI Investment and Energy Savings

	Investment as of March 2002, $000 000	Estimated Annual Energy Savings, Terajoules per Year
National Defence	104.8	11.80
Public Works and Government Services Canada	42.6	6.90
Other departments	20.1	3.29
Industry Canada	15.5	2.84
Natural Resources Canada	9.2	1.00
Environment Canada	8.7	1.10

FIGURE 9-3: Energy Savings from FIBP, 1991–1992 to 2001–2002
(terajoules per year)

	1991–1992	1992–1993	1993–1994	1994–1995	1995–1996	1996–1997	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002
Annual increment	20	50	40	70	90	80	77	77	93	103	112
Annual total savings	20	70	110	180	270	350	427	504	597	700	812

FIGURE 9-4: Federal Fleet Size and Fuel Consumption, 1995–1996 to 1999–2000
(litres of gasoline equivalent [thousands])

	1995–1996	1997–1998	1999–2000
Total fuel consumption (Litres of gasoline equivalent)	88 725	75 684	78 281
Vehicles	24 854	22 796	22 462

FIGURE 9-5: Purchase of ATF Vehicles for the Federal Fleet
(vehicles purchased)

	Annual	Cumulative
1997–1998	135	135
1998–1999	159	294
1999–2000	179	473

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The Office of Energy Efficiency of Natural Resources Canada strengthens and expands Canada's commitment to energy efficiency in order to help address the challenges of climate change.

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